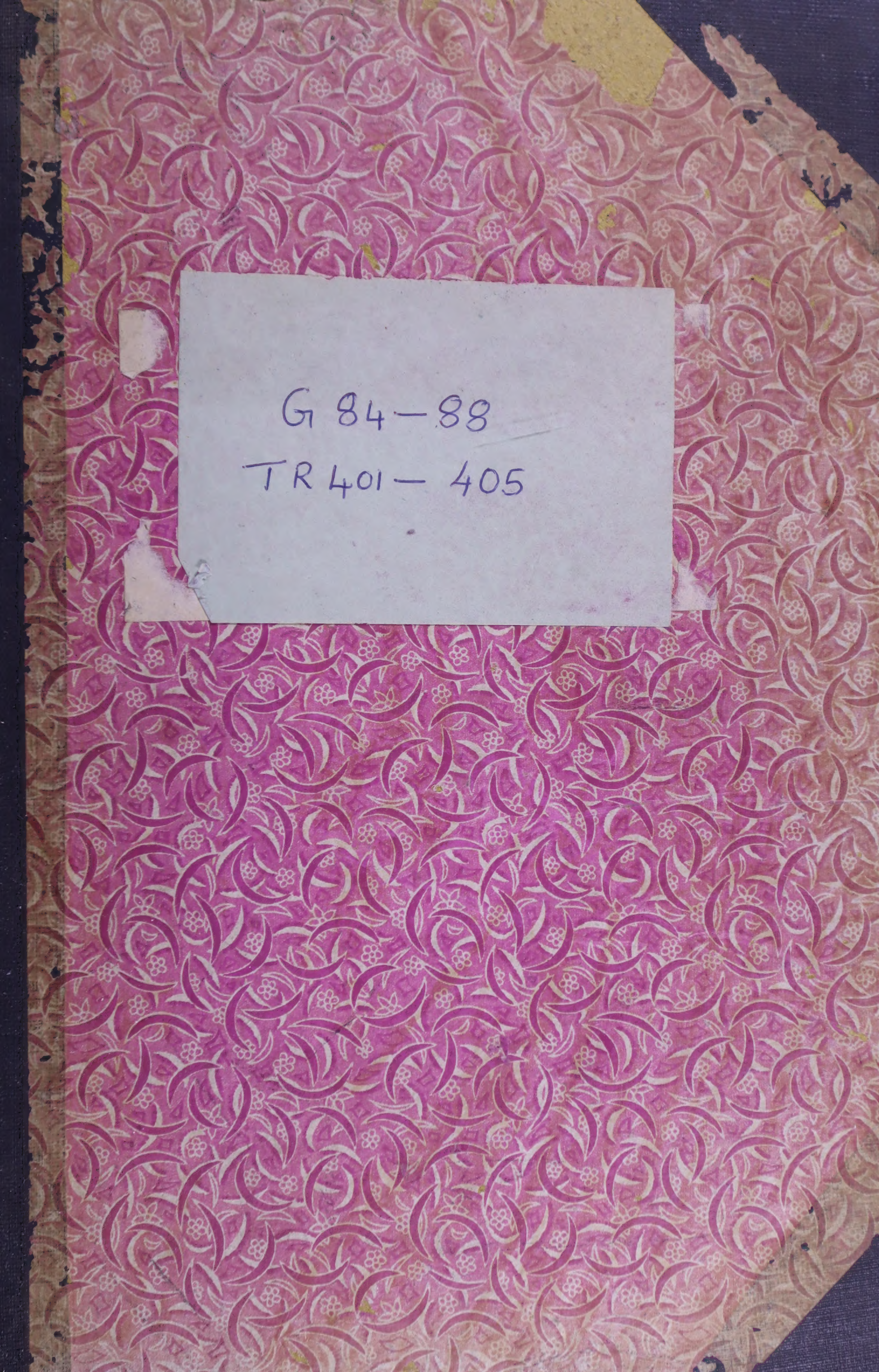

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The structure of the pepper market in the United Kingdom, the Federal Republic of Germany, the Netherlands and France

Patrick Breslin and Andrew Jones

November 1973

Tropical Products Institute 56/62 Gray's Inn Road London WC1X 8LU
Foreign and Commonwealth Office (Overseas Development Administration)

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Contents

Page

INTRODUCTION AND SUMMARY 1
- Introduction and Summary 1
- Introduction et Sommaire 3
- Presentacion y Resumen 6

THE UNITED KINGDOM 10
- Organisation of the import trade 10
- Stocks 12
- Sources of imports and market preferences 13
- Distribution 15
- Prices and margins 17
- Consumption 18

THE FEDERAL REPUBLIC OF GERMANY 19
- Organisation of the import trade 19
- Stocks 21
- Sources of imports and market preferences 22
- Distribution 22
- Prices and margins 23
- Consumption 24

THE NETHERLANDS 25
- Organisation of the import trade 25
- Stocks 26
- Sources of imports and market preferences 27
- Distribution 27
- Prices and margins 28
- Consumption 29

FRANCE 30
- Organisation of the import trade 30
- Stocks 34
- Sources of imports and market preferences 34
- Distribution 36
- Prices and margins 37
- Consumption 39

TRADE SOURCES CONSULTED IN THE PREPARATION OF THE STUDY 41

STATISTICAL APPENDIX AND LIST OF TABLES 44

The structure of the pepper market in the United Kingdom, the Federal Republic of Germany, the Netherlands and France

INTRODUCTION AND SUMMARY

An examination of the markets for pepper in the countries reviewed in this study shows that the individual market structures have certain basic characteristics in common. Thus, it is possible to give a simplified description of pepper marketing which would apply to all four countries. Grinders mostly buy pepper from dealers, either direct or through the services of a broker, for processing, packing and onward sale to food manufacturers, wholesalers, retailers and institutional caterers. Grinders also purchase direct from origin (in certain instances this may be done through a broker).

At the centre of the distribution system, therefore, are the grinders. The bulk of the pepper bought by grinders is purchased from dealers in London, Rotterdam and Hamburg. Dealers place orders for shipment direct at origin ("origin" here includes Singapore as well as the actual producing areas), where they have their individual contacts or representatives. However, dealers do not normally import pepper in the strict sense of the word: that is, they do not clear consignments through customs, at which point pepper is actually imported into a country. Pepper is sold to grinders by dealers either before shipment from origin, or while a vessel carrying pepper is in transit from the producing area to a European port, or occasionally from a bonded warehouse at a European port. Grinders are responsible for port and customs clearance and thus become the actual importers. The import duty on whole pepper in the European Economic Community is 10 per cent; in the United Kingdom it enters free of duty.

Dealers buy pepper on their own account. Their function of selling pepper to grinders is interrelated with their speculative activities. It is important, however, to distinguish between trading in physical pepper for actual consumption and trading on a purely speculative basis. The principal dealers in London, Rotterdam and Hamburg are trading on an international basis, not simply on the basis of their own domestic markets. Consumption of pepper in the Netherlands, for example, is less than a thousand tons per annum, yet the physical flow of pepper through the port of Rotterdam is much greater. Contracts for shipment of pepper from origin are usually made on the basis of shipment to London, Rotterdam or Hamburg on optional bills of lading. The dealer then has the option of directing the goods to any of these ports. Moreover, pepper is also shipped from one European port to another, according to the situation in the market. This European "transit" trade in pepper is not recorded in the trade statistics, since it is only at its final destination that the pepper actually enters the country and is recorded as an import.

No one active in the pepper market was prepared to estimate the size of this transit trade for London, Rotterdam or Hamburg, on the grounds that it was impossible to hazard even a meaningful guess. A factor mitigating against any meaningful estimate is that a percentage of any dealer's turnover in pepper is almost purely speculative, and the extent of such speculation varies from dealer to dealer. Speculation in pepper is conducted among dealers within the European market. This is a purely "paper" transaction. In West Germany, for example, where the consumption of pepper is around 6,000 tons per annum, actual trading of pepper among dealers may involve contracts totalling at least three or four times this amount. Speculation is conducted on the basis of parcels of pepper, a parcel always being five tons. Dealers take "long" or "short" positions in the market, according to how they consider the price of pepper is likely to move. Thus, if a dealer sells "short", he is contracting to sell pepper, which he does not possess, at a future date for an agreed price. If a dealer holds a "long" position, this means he has unsold pepper on his trading account. One parcel of pepper may be traded several times over among a number of dealers.

Dealers trade in pepper with the intention of making a profit. They do, of course, make losses as well as gains. The forward position which dealers take will vary. One European dealer, for example, sold "short" in March, 1972 for July/August, 1973, although his contacts were mostly for November/December, 1972. European dealers contend that their speculative activities are necessary in order to provide regular, year-round supplies of pepper to grinders. Without speculation, it is maintained, grinders would have to purchase their annual requirements in fewer and larger consignments — with the obvious cost disadvantages involved in both paying for and holding such substantial quantities — instead of, as at present, buying smaller consignments as and when they need them.

Speculation takes place mainly in Sarawak pepper, and only to a limited extent in Indonesian and Brazilian. The reason for this is that, whereas there is Government intervention in the export of Indonesian pepper, and the export of Brazilian pepper is largely in the hands of one marketing organisation, with Sarawak pepper there are no such restraints. In Europe, there are two companies — one in West Germany and one in the Netherlands — which are reported to be directly linked with the official exporting groups in Indonesia. Most European dealers maintain that their speculative activities are of minor importance compared with those of the Chinese dealers in Singapore.

Whereas dealers trade in pepper on their own account, brokers perform the traditional function of acting as intermediaries between buyer and seller, receiving a commission for their services — normally one per cent from the seller and, in some instances, one half per cent from the buyer. Moreover, whereas dealers are in direct contact with origin, brokers are not normally so; they operate between dealer and dealer, or dealer and grinder. However, in the European trade, the actual operations of brokers are not always so clear cut. Some brokers also deal in pepper on their own account; in other words, they also act as dealers as described above. These activities are referred to later in this report. Brokers are normally in constant communication with the main pepper dealers in London, Rotterdam and Hamburg. Some tend to specialise in servicing grinders, while others are more involved with servicing trade between dealers. They provide market intelligence to their customers as well as arranging contacts between buyer and seller and handling the shipping documents. Pepper is normally traded on the No.5 contract of the General Produce Brokers Association of London.

Grinders buy pepper from dealers, either direct or through the services of a broker, and also to some extent direct from origin. Some grinders may also speculate a little by selling pepper to other buyers, usually through a broker. All grinders carry stocks; pepper can be stored for long periods without deteriorating. The size of these stocks depends to some extent on the price of pepper and the cost of holding them, but is largely determined by the grinder's turnover. It would appear that most grinders tend to maintain stock levels at around 20 per cent of annual requirements, although the very large grinders may keep up to 30 per cent. There is a tendency to increase stocks when prices are low but, in view of the costs involved, the extent to which grinders are able or willing to do this is limited.

Dealers, in general, are also reluctant to hold stocks of pepper because of the costs involved. In Rotterdam one large international dealer has at times held 200-300 tons of pepper in bonded warehouses but this is exceptional. Stocks in the free port of Hamburg are said by dealers to be less than those in Rotterdam, while no London dealers reported holding any stocks at all. In France, there are no dealers as such and the only stocks are those of the grinders. Thus, the holding of physical stocks by European dealers for speculative purposes, significant as it was in former years, is no longer important.

It is difficult to establish the relationship between dealers' speculation in Europe and price fluctuations. It is generally acknowledged that the main factors leading to price fluctuations in pepper arise on the supply side. The price at which European buyers can obtain supplies of pepper largely depends on two main factors: the size of the world pepper crop, and the activities of traders and dealers both in the producing countries and in Singapore. It has already been pointed out, however, that speculation takes place principally in Sarawak pepper. The bulk of Sarawak's exports goes to Singapore, the main centre of speculative activity in pepper. It is therefore relevant to consider the trading activities of Singapore dealers.

The view of the market taken by Singapore dealers (and other traders in the countries of origin) will tend to be governed by the expected size of the crop in relation to carryover stocks from the previous year (given a relatively inelastic demand for pepper in the importing countries) and their subsequent trading activities will reflect the view taken. European dealers take account of these same factors but, additionally, their trading activities have to respond to the influence exerted by the activities of the dealers in Singapore. If, in addition to the factors of size of crop and carryover stocks, speculation is considered to contribute to or intensify price fluctuations, then it is reasonable to suggest that one must look first at speculation in Singapore, rather than in Europe, in order to assess its true impact.

The general aspects of the European pepper market described so far are more fully developed in those sections of the report which survey the countries individually. Trading and marketing characteristics particular to any one country are identified and described.

Data relating to consumption in the countries studied, including projections to 1980, are contained in the statistical appendix and reviewed in the individual country sections of the report.

INTRODUCTION ET SOMMAIRE

La structure du marche du poivre au Royaume-Uni, dans la République Fédérale Allemande, en Hollande et en France

Un examen des marchés du poivre dans les pays passés en revue dans cette étude indique que les structures des marchés individuels ont certaines caractéristiques de base en commun. Il est donc possible de donner une description simplifiée du marché du poivre qui puisse s'appliquer à tous ces quatre pays. Les broyeurs achètent le plus souvent le poivre aux négociants soit directement soit par l'intermédiaire d'un courtier, à fins de traitement, empaquetage et vente ultérieure aux fabricants d'aliments, grossistes, détaillants et traiteurs officiels. Les broyeurs ont également la possibilité d'effectuer leurs achats directement au point d'origine (dans certains cas, ceci peut être effectué par l'intermédiaire d'un courtier).

Au centre du système de distribution se trouvent donc les broyeurs. La majorité du poivre qu'achètent les broyeurs est acheté chez des marchands à Londres, Rotterdam et Hambourg. Les marchands passent leurs commandes directement au point d'origine ("origine" dans ce contexte comprend Singapour aussi bien que les zones

réelles de production), où ils disposent de leurs contacts ou représentants individuels. Cependant, les marchands n'importent pas généralement le poivre au sens précis du mot: en effet, ils ne dédouanent pas les envois là où le poivre est réellement importé dans un pays. Le poivre est vendu aux broyeurs par les marchands soit avant l'expédition du point d'origine, soit lorsqu'un vaisseau qui transporte le poivre est en transit de la zone de production vers un port européen, soit parfois à partir d'un entrepôt réel à un port européen. Les broyeurs sont responsables du dédouanement et des formalités au port et deviennent donc les importateurs réels. Les droits d'importation pour tout le poivre dans la Communauté Economique Européenne sont de 10%; au Royaume-Uni, il est exempt de droits.

Les marchands achètent le poivre pour leur propre compte. Leur rôle de vente du poivre au broyeur est étroitement lié à leurs activités spéculatives. Cependant, il est important de faire la différence entre le commerce du poivre à proprement parler à fins de consommation véritable et le commerce sur une base purement spéculative. Les négociants principaux de Londres, Rotterdam et Hambourg font du commerce sur une base internationale et non simplement sur la base de leurs propres marchés intérieurs. Ainsi, par exemple, la consommation du poivre en Hollande est inférieure à mille tonnes par an mais l'écoulement physique du poivre par le porte de Rotterdam est nettement supérieur. Les contrats pour l'expédition du poivre du point d'origine sont généralement effectués sur la base d'expédition à Londres, Rotterdam ou Hambourg sur des connaissements optionnels. Le négociant a alors le choix de diriger les marchandises vers n'importe lequel de ces ports. En outre, le poivre est également expédié d'un port européen à un autre, suivant la conjecture du marché. Ce "transit" européen n'est pas enregistré dans les statistiques commerciales car c'est uniquement lors de sa destination finale que le poivre entre dans le pays et qu'il est enregistré comme importation.

Il ne s'est trouvé personne sur le marché du poivre prêt à estimer le volume du commerce en transit pour Londres, Rotterdam ou Hambourg du fait qu'il était impossible de deviner une réponse qui soit valable. Un facteur qui empêche toute estimation valable est le fait qu'un pourcentage du chiffre d'affaires d'un négociant en poivre est presque purement spéculatif et l'importance d'une spéculation de ce genre varie d'un négociant à un autre.

La spéculation en poivre est effectuée parmi les négociants au sein du marché européen. Il s'agit là d'une transaction uniquement "sur papier". Ainsi, par exemple, en Allemagne de l'Ouest où la consommation du poivre est d'environ 6.000 tonnes par an, le commerce véritable du poivre parmi les négociants peut entraîner des contrats d'un total d'au moins trois ou quatre fois cette somme. La spéculation est effectuée sur la base de lots de poivre, un lot de poivre étant toujours de cinq tonnes. Les négociants prennent des positions "long terme" ou "court terme" sur le marché selon la manière dont ils estiment que le prix du poivre va se déplacer. Ainsi, si un négociant vend "à court terme" il s'engage à vendre du poivre qu'il ne possède pas à une date ultérieure et à un prix convenu. Si un négociant tient une position "à long terme" ceci veut dire qu'il a du poivre non vendu sur ses comptes commerciaux. Un lot de poivre peut ainsi être vendu plusieurs fois au sein d'un nombre de négociants.

Les négociants font le commerce du poivre dans le but de faire un bénéfice. Il est évident qu'ils subissent des pertes de la même manière qu'ils font des bénéfices. La position que prennent les négociants varie. Ainsi, par exemple, un négociant européen a vendu "à court terme" en mars 1972 pour juillet/août 1973 bien que ses contrats étaient principalement pour novembre/décembre 1972. Les négociants européens soutiennent que leurs activités spéculatives sont nécessaires afin de permettre des fournitures de poivre régulières aux broyeurs pendant toute l'annee. Ils affirment que sans spéculation, les broyeurs devraient acheter leurs besoins annuels en moins d'envois plus importants, — avec les inconvénients financiers évidents dus au paiement et au maintien de quantités importantes — au lieu d'acheter des envois plus petits de la manière et à la date dont ils en ont besoin ainsi qu'ils le font à présent.

La spéculation se fait principalement sur le poivre de Sarawak et en petites quantités seulement sur le poivre d'Indonésie et du Brésil. La raison en est la suivante: alors que le Gouvernement intervient dans l'exportation du poivre d'Indonésie et que l'exportation du poivre du Brésil est principalement dans les mains d'une seule organisation de marketing, il n'existe pas de restrictions de ce genre avec le poivre de Sarawak. En Europe il y a deux Sociétés – l'une en Allemagne de l'Ouest et l'autre en Hollande – qui sont dites être directement liées aux groupes officiels d'exportation en Indonésie. La plupart des négociants européens maintiennent que leurs activités spéculatives sont d'importance mineure comparées à celles des négociants à Singapour.

Alors que les négociants font le commerce du poivre pour leur propre compte les courtiers accomplissent le rôle traditionnel d' intermédiares entre l'acheteur et le vendeur et recoivent une commission pour leurs services-généralement 1% du vendeur et dans certains cas ½% de l'acheteur. En outre, alors que les négociants sont en contact direct avec le point d'origine, les courtiers ne le sont généralement pas; ils agissent entre négociant et négociant ou entre négociant et broyeur. Cependant, dans le commerce européen, les agissements véritables des courtiers ne sont pas toujours déterminés avec précision. Certains courtiers font également le commerce du poivre pour leur propre compte; en d'autres termes, ils agissent également comme négociants de la manière décrite ci-dessus. Il est fait référence de ces activités plus loin dans ce rapport. Les courtiers sont généralement en communication constante avec les négociants principaux en poivre à Londres, Rotterdam et Hambourg. Certains tendent à se spécialiser dans la vente aux broyeurs tandis que d'autres s'occupent plus spécialement de la promotion du commerce entre les négociants. Ils communiquent à leurs clients des renseignements sur le marché, s'occupent des contrats entre l'acheteur et le vendeur et traitent des documents d'expédition. Le commerce du poivre est généralement effectué sur le contrat No. 5 de l'Association des Courtiers de Produits Générales de Londres.

Les broyeurs achètent le poivre chez les négociants soit directement soit par l' intermédiaire d'un courtier et dans une certaine mesure directement à partir du point d'origine. Certains broyeurs peuvent également spéculer en vendant le poivre à d'autres acheteurs généralement par l'intermédiaire d'un courtier. Tous les broyeurs ont des stocks; il est possible de stocker le poivre pendant de longues durées sans qu'il ne se détériore. Le volume de ces stocks dépend en partie du prix du poivre et du coût du maintien mais il est déterminé en grande partie par le chiffre d'affaires du broyeur. Il semble que la plupart des broyeurs tendent à maintenir des stocks à environ 20% au dessus de leurs besoins annuels, mais les broyeurs les plus importants les maintiennent parfois jusqu'à 30%. La tendance est d'augmenter les stocks lorsque les prix sont bas mais par suite du coût que cela représente, la mesure dans laquelle les broyeurs sont capables ou désireux d'effectuer cette opération est limitée.

En général, les négociants hésitent à maintenir des stocks de poivre par suite des frais que cela entraîne. A Rotterdam, un important négociant international a de temps à autre gardé de 200 à 300 tonnes de poivre dans des entrepôts réels mais c'est exceptionnel. Les négociants soutiennent que les stocks dans le port libre de Hambourg sont inférieurs à ceux de Rotterdam alors qu'aucun négociant de Londres n'affirme tenir de stock. En France, il n'y a pas de négociants en tant que tels et les seuls stocks sont ceux des broyeurs. Ainsi, le maintien de stocks réels par les négociants européens à fins de spéculation n'est plus aussi important qu'il l'était dans le passé, où il n'était pas négligeable.

Il est difficile d'établir un rapport entre la spéculation des négociants en Europe et les fluctuations de prix. Il est généralement reconnu que les facteurs principaux qui entraînent des fluctuations de prix du poivre proviennent du côté fourniture. Le prix auquel les acheteurs européens peuvent obtenir l'approvisionnement du poivre dépend principalement de deux facteurs: le volume de la récolte mondiale et les activités des négociants et commerçants dans les pays de production ainsi qu'à Singapour. On a déjà mentionné, cependant, que la spéculation a lieu principalement sur le poivre de Sarawak. La majorité des exportations de Sarawak va à Singapour, le centre principal de l'activité spéculative sur le poivre. Il est donc approprié de considérer les activités commerciales des négociants de Singapour.

La considération du marché vue par les négociants de Singapour (et les autres commerçants des pays d'origine) tend à être commandée par le volume prévu de la récolte par rapport aux stocks de transport (en supposant une demande relativement non élastique pour le poivre dans les pays importateurs) et les activités de commerce qui s'ensuivent reflèteront leur prise de position. Les négociants européens tiennent compte de ces mêmes facteurs mais leurs activités de négoce doivent en outre réagir à l'influence exercée par les activités des négociants à Singapour. Si, en plus des facteurs du volume de la récolte et des stocks de transport, on estime que la spéculation contribue aux fluctuations de prix ou les intensifie, il est raisonnable de suggérer qu'il convient tout d'abord de considérer la spéculation à Singapour plutôt qu'en Europe afin de déterminer son influence véritable.

Les aspects généraux du marché européen du poivre décrits jusqu'à présent sont développés avec plus de détails dans les sections du rapport qui étudient les pays individuellement. Les caractéristiques de commerce et du marché particulières à chaque pays sont identifiées et décrites.

Les données en égard à la consommation dans les pays étudiés, y compris les prévisions jusqu'à 1980, sont contenues dans l'annexe de statistique et elles sont passées en revue dans les sections des pays individuels du rapport.

PRESENTACION Y RESUMEN

Estructura del mercado de pimienta en el Reino Unido, Republica Federal de Alemania, Holanda y Francia.

Habiendo examinado el mercado de pimienta en los países citados en este informe, se ha llegado a la conclusión de que en las diferentes estructuras del mercado se observan características básicas comunes. De esta forma, es posible dar una descripción simplificada de la comer cialización de pimienta, aplicable a los cuatro países mencionados. Los fabricantes/molenderos compran la pimienta principalmente a tratantes, bien directamente o a través de agente, para su fabricación, empaquetado y posterior venta a fabricantes de productos alimenticios, mayoristas, detallistas y abastecedores de grandes establecimientos. Los molenderos compran tambien directamente en origen (en algunas ocasiones a través de agente).

En el centro del sistema de distribución se encuentran, por tanto, los molenderos. La mayor parte de la pimienta adquirida por los mismos es suministrada por tratantes en Londres, Rotterdam y Hamburgo. Estos colocan los pedidos para su embarque directo en origen (por "origen" se entiende igualmente Singapur así como las zonas productoras) donde mantienen contactos personales y representantes. Sin embargo, los tratantes no importan pimienta en el estricto sentido de la palabra: es decir, no retiran la mercancía de Aduana, lo cual es lo que realmente dá a la mercancía el carácter de importación. La pimienta es vendida a los molenderos por los tratantes antes de su embarque en origen, o bien, durante el transporte de la misma desde la zona productora a un puerto europeo, e incluso en ocasiones desde los depósitos de Aduanas en un puerto europeo. Los molenderos se responsabilizan de la retirada de la mercancía del puerto o Aduana con lo que se convierten en los verdaderos importadores. Los derechos de Aduana por lo que respecta a pimienta sin moler, en la Comunidad Económica Europea, es de un 10%; en el Reino Unido no paga derechos de entrada alguno.

Los tratantes compran pimienta por su cuenta y riesgo. Su función como vendedores del producto a los molenderos está interrelacionada con sus actividades especulativas. Es importante distinguir, sin embargo, entre la compra-venta física de pimienta para su consumo, y la puramente especulativa. Los principales tratantes en Londres, Rotterdam y Hamburgo operan de acuerdo con usos internacionales, y no simplemente de acuerdo con sus respectivos mercados internos. El consumo de pimienta en Holanda, por ejemplo, es de menos de mil toneladas anuales, y sin embargo, el movimiento del producto en el puerto de Rotterdam es mucho mayor. Los contratos de embarque de pimienta desde origen se hacen normalmente con destino a Londres, Rotterdam o Hamburgo en conocimientos de embarque discrecionales. Los tratantes deciden más tarde el puerto de recepción de la mercancía de entre los tres mencionados. Por otra parte, la pimienta se envía tambien desde un puerto europeo a otro, según la situación del mercado. Este comercio europeo ''de tránsito'' no se registra en las estadísticas comerciales, ya que es sólo en destino donde la pimienta realmente entra en el país y es registrada como importación.

Ninguna de las partes relacionadas con el mercado de pimienta estaba dispuesta a efectuar una estimación del volumen de este comercio de tránsito entre Londres, Rotterdam o Hamburgo, debido a que, según las mismas, era imposible aventurar una cifra siquiera aproximada. Una de las causas que explican esta imposibilidad es el hecho de que un porcentaje del negocio de cualquier tratante en pimienta es casi puramente especulativo, y el alcance de esta especulación varía de unos a otros. La especulación en pimienta se realiza entre tratantes dentro de los mercados europeos. Esta es simplemente una transacción ''sobre el papel''. En Alemania Occidental, por ejemplo, donde el consumo de pimienta es de unas seis mil toneladas al año, el comercio entre tratantes puede originar contratos que totalizan tres o cuatro veces este importe por lo menos. La especulación se efectúa a base de paquetes de pimienta, conteniendo cada paquete cinco toneladas del producto. Los tratantes operan sobre posiciones ''largas'' o ''cortas'' de mercado, según ellos consideren la probabilidad de fluctuación en el precio. Así, si un tratante vende a ''corto'', está efectuando un contrato de venta de pimienta, que él no posee, en fecha futura a un precio acordado de antemano. Si el tratante mantiene una posición ''a largo'' significa que tiene pimienta sin vender en su cuenta comercial. Un paquete de pimienta puede ser vendido repetidas veces entre varios tratantes.

Los tratantes comercian el producto con la intención de obtener un beneficio. Naturalmente, también sufren pérdidas. La posición tomada por los mismos para el futuro varía a menudo. Por ejemplo, uno de ellos, europeo, vendió ''a corto'' en Marzo de 1972 para Julio/Agosto de 1973, si bien sus contratos eran principalmente para Noviembre/Diciembre de 1972. Los tratantes europeos afirman que sus actividades especulativas son necesarias para abastecer regularmente a los molenderos a lo largo del año. Sostienen que, sin la especulación, los molenderos tendrían que comprar sus necesidades anuales en pequeños o grandes pedidos — con los consiguientes inconvenientes en cuanto a forma de pago y a la posesión de cantidades tan considerables — en lugar de comprar pequeños pedidos como se hace ahora a medida que sus necesidades lo aconsejen.

La especulación tiene lugar principalmente con pimienta Sarawak, y sólo hasta cierto punto con la procedente de Indonesia y Brasil. Esto se debe a que, mientras existe intervención gubernamental en la exportación de pimienta de Indonesia, y la brasileña controlada en su mayoría por una organización comercial, no ocurre lo mismo con la pimienta Sarawak. Hay dos firmas en Europa — una en Alemania Occidental y otra en Holanda — que se sabe están directamente relacionadas con los grupos oficiales exportadores de Indonesia. La mayoría de tratantes europeos afirman que sus actividades especulativas son de poca importancia comparadas con las de sus colegas chinos en Singapur.

Mientras los tratantes negocian en pimienta por su propia cuenta, los agentes realizan la función tradicional de intermediarios entre comprador y vendedor, recibiendo comisión por sus servicios — normalmente un 1% a cargo del vendedor y en ocasiones, un ½% del comprador. Además, mientras los tratantes operan directamente con origen, los agentes no lo hacen generalmente; trabajan entre tratante y tratante, o entre tratante y molendero. Sin embargo, en el comercio europeo, la operativa de los agentes no está siempre definida con claridad. Algunos de ellos también comercian por su cuenta; en otras palabras, operan de la misma forma que los tratantes, de la forma descrita con anterioridad. Sus actividades se señalan más adelante en este informe. Los agentes están normalmente en comunicación constante con los principales tratantes de Londres, Rotterdam y Hamburgo. Algunos se especializan en abastecer molenderos, mientras que otros operan el intercambio entre tratantes. Suministran información del mercado a sus clientes y también preparan contratos entre comprador y vendedor y tramitan los documentos de embarque. Las transacciones de pimienta se realizan según el contrato No. 5 de la Asociación de Agentes de Productos Generales, de Londres.

Los molenderos compran la pimienta a los tratantes, bien directamente, o a través de un agente; algunas veces también directamente en origen. Algunos molenderos tienden a especular un tanto vendiendo pimienta a otros compradores, generalmente por mediación de agente. Todos los molenderos mantienen existencias en su poder; la pimienta puede ser almacenada durante largo tiempo sin deterioro alguno. La cantidad de las existencias depende bastante del precio de la pimienta y del coste de almacenaje, pero generalmente es determinada por el volumen de negocio del molendero. Estos tienden a mantener un nivel de existencias de un 20% de sus necesidades anuales, aunque los grandes molenderos pueden llegar a un 30%. Existe una tendencia a incrementar estas existencias cuando los precios son bajos, pero debido al coste que ésto supone, queda muy limitada la capacidad o deseo de hacer ésto por parte de los molenderos.

Los tratantes, en general, no están tampoco muy dispuestos a mantener existencias de pimienta debido al coste que ésto supone. En Rotterdam, un tratante de escala internacional mantiene a veces de 200 a 300 toneladas de pimienta en depósitos aduaneros, pero es una excepción. Según los tratantes, las existencias en el puerto franco de Hamburgo son menores que las de Rotterdam, mientras que en Londres se cree no existe mercancía alguna. En Francia no existen tratantes como tal, estando las únicas existencias en poder de molenderos. De esta forma, la posesión física del producto por tratantes europeos para fines especulativos, si bien considerable durante los primeros años, carece ahora de importancia.

Es difícil establecer la conexión entre la especulación efectuada por tratantes en Europa y las fluctuaciones en precio. Se cree generalmente que las causas principales de estas fluctuaciones se originan en la parte abastecedora. El precio al cual los compradores europeos pueden adquirir la pimienta, depende en gran parte de dos factores primordiales: el volumen de cultivo de pimienta en el mundo, y las actividades de comerciantes y tratantes, tanto en los paises productores como en Singapur. Se ha mencionado ya, sin embargo, que la especulación se efectúa principalmente en la pimienta Sarawak. El volumen de exportación de Sarawak se dirige a Singapur, que es el centro principal de la activadad especulativa. Es por tanto primordial, considerar las actividades comerciales de los tratantes en Singapur.

La actitud tomada por los tratantes en Singapur (y otros comerciantes en los paises de origen) tiende a estar influenciada por las perspectivas de cosecha futura en relación con la cosecha del año anterior todavia en existencia, (teniendo en cuenta una demanda rígida de pimienta en los paises importadores) por lo que sus consiguientes actividades comerciales serán un reflejo de la actitud tomada. Los tratantes europeos consideran estos mismos factores, pero además, sus actividades comerciales han de responder a la influencia que sobre ellos ejercen las actividades de sus colegas en Singapur. Si, además de estos factores de volumen de cultivo y mercancía en existencia, se considera la especulación como factor contribuyente a la intensificación de las fluctuaciones del precio, creemos razonable efectuar un examen de la especulación en Singapur como primer paso, y no en Europa, con objeto de valorar su verdadero impacto.

Los aspectos generales del mercado de pimienta en Europa descritos hasta ahora han sido más profundamente estudiados en las secciones del informe que tratan cada país por separado. Las características de comercialización de cada país en particular se describen y explican convenientemente.

La información relativa al consumo en los países descritos y la proyección para 1980 están contenidas en el apéndice estadístico, y revisadas en las secciones del informe que trata cada país por separado.

The United Kingdom

ORGANISATION OF THE IMPORT TRADE

London has always been an important trading centre for pepper. Before the Second World War there were upwards of thirty brokers acting as buying and selling agents on behalf of users and dealers, both in the United Kingdom and throughout the world. Now, however, almost the entire broking and dealing function is concentrated in the hands of six companies.

Brokers

Brokers in London mostly operate under two sets of circumstances. First, in transacting sales of pepper between dealers, each of whom does not wish his identity to be known by the other: secondly, in obtaining supplies for users both in the United Kingdom and those elsewhere. Those United Kingdom food manufacturers who import pepper themselves invariably use the services of a broker, as do the smaller specialist grinders and packers. The larger grinders also buy through brokers, although most of their requirements are supplied direct from origin or by dealers. Of total United Kingdom imports, about 25 per cent are obtained via a broker (this is only a very rough estimate, as not even the brokers themselves know what proportion of their turnover is finally consumed in the United Kingdom).

Pepper broking, however, has significantly declined in importance in recent years. Apart from two dealer/brokers, who both concentrate their activities on dealing (which accounts for about 80 per cent of their pepper business), only two specialist or "pure" brokers remain. These two firms act only as brokers, and never take a position in the market on their own account. Neither of them deals direct with origin, and they act only as intermediaries between dealers and/or users. One of these two brokers expects to have a turnover of about 1000 tons in 1972. Approximately half of his business is on behalf of overseas buyers, mostly in West Germany, but also in Holland. It often happens that a broker, when acting on behalf of dealers, will arrange the purchase and sale of one shipment of pepper several times over. Indeed, one broker reported having recently bought and sold one shipment six times over on behalf of various principals.

Dealers

Basically, as explained in the introduction, a dealer operates by taking a position in the market. He can do this in one of two ways. By buying forward (or 'long'), a dealer buys pepper, sometimes even before it has actually been harvested, for shipment some time ahead, in anticipation of the supply situation tightening, with a resulting increase in prices. This will allow him to sell at a later date for a price in excess of that which he paid. When selling forward (or 'short'), a dealer sells pepper that he does not yet own to a buyer, at a price agreed when the order is placed, for shipment sometime in the future. In this instance, the dealer is anticipating that prices will fall, and that he will be able to obtain supplies to fulfil the order for less than the contracted price.

Almost all business of this nature that is carried on in the United Kingdom is channelled through the hands of four companies. Only one of these firms acts solely as a dealer, the others also acting as brokers on behalf of buyers and sellers, for a commission. Dealing, however, is the more important activity for these latter companies, accounting for between 70 and 80 per cent of their business. Actual quantities traded in this way on the London market vary enormously from year to year, depending largely on the size of the pepper crop, and on the activities of dealers in the countries of origin and in Singapore. One company, however, claimed an average annual dealing turnover of several times the annual pepper consumption of the United Kingdom. Most transactions on the London market are with other dealers in Rotterdam, Hamburg and Singapore. Some business is also carried out, however, with buyers in the United States, who often buy through London because of time zone differences between themselves and the major producing countries of South East Asia. In such an instance, an order is cabled through to London. The United Kingdom dealer will then cable the prices pertaining at origin to the United States, where the buyer will either accept or reject. Although the dealer is buying on his own account in such transactions, he only buys a specific quantity to be sold at the price already agreed with the buyer and obtains the normal broker's commission from the seller. He is thus acting partly as a dealer and partly as a broker. Pepper that is supplied in this way to users in the United States is purchased at origin for shipment on an American bound vessel. Between 40 and 50 per cent of the purchases of pepper by users in the United Kingdom are obtained direct from dealers.

Dealers in London no longer hold stocks of pepper themselves, as renting warehouse space is very expensive. Margins are slim and competition between dealers is very intense, consequently any additional expense involved in stockholding is not worthwhile. The cost of landing and warehousing one ton of pepper is, at present, about £9, and this must be cleared within three days. Dealers do occasionally, however, miscalculate the demand for pepper and buy forward more than they are able to sell before it arrives in London. What normally occurs when this happens, is that the dealer will sell off the surplus to a grinder, at rather less than the current price, before the consignment is unloaded from the ship.

Although, as pointed out above, intense competition exists between most of the members of the dealing and broking community in London, one of the two "pure" brokers is part of the same commercial group as one of the larger dealer/brokers. Another dealer/broker is part of an international group of companies which also includes a pepper trader in Hamburg.

Grinders

Virtually all pepper imported into the United Kingdom goes to grinders – this includes food manufacturers and spice extractors and distillers with their own grinding facilities. Over recent years, most grinders have been importing increasing quantities of pepper direct from origin, thus by-passing both dealers and brokers. A current estimate of the proportion of total United Kingdom imports obtained in this way, based on information supplied by the major users, is that between 25 and 30 per cent of supplies are obtained direct. (Even with "direct" shipments, however, the pepper may have first passed through the hands of a number of dealers in the producing country). It is only the very large United Kingdom grinders, with an annual turnover in excess of about 500 tons per annum, that buy pepper in this way. The smaller ones almost invariably use the services of a broker. Almost all grinders buy pepper cif London. One particular firm, however, also acts as a dealer when the opportunity arises, and thus prefers to buy cif London, Rotterdam, Hamburg. Between 5 and 10 per cent of its annual purchases, amounting to perhaps 100-200 tons, are bought for trading purposes, to be sold to other dealers.

In the United Kingdom, there are certain commercial links between various companies within the pepper market which are significant. Of the three major United Kingdom grinders, two are directly associated with important commodity broking and dealing firms, and thus have direct links with almost all available sources of supply within their own corporate organisations. Both, however, are free to buy from sources, or through brokers, outside their own respective commercial groups, in order to maximise the flexibility and effectiveness of their individual purchasing policies. One of these two grinders maintains a permanent agent in Sarawak, and obtains about 50 per cent of its supplies direct from origin. The other is understood to be in the process of establishing substantial storage facilities for pepper in Sarawak.

Trade associations

All the major United Kingdom pepper brokers belong to the General Produce Brokers Association of London (GPBAL), and are represented within this organisation by a spice committee. The general aims of the Association are to foster and promote trade, and to protect the interests of the member companies.

Special pepper contracts, issued by the GPBAL, are by far the most widely used contact forms throughout Europe, and the Association has its own arbitration rules for settling any disputes which may arise between buyers and sellers. A monthly statement of stocks held in Port of London Authority warehouses is also published.

Owing to the substantial decline in the number of brokers active in the spice trade in the United Kingdom over the past few years, the GPBAL is trying to broaden its base by attempting to attract all sections of the trade on an international basis.

Import duties and taxes

Duty was formerly imposed on pepper imported into the United Kingdom from all sources outside the Commonwealth, but now all imports enter duty free.

There are no internal taxes on pepper in the United Kingdom.

STOCKS

United Kingdom dealers no longer hold stocks of pepper. Quantities held in Port of London Authority warehouses are now also insigificant, amounting to only 17 tons at the end of June 1972.

The only firms now holding significant stocks of pepper in the United Kingdom are the grinders, and the average quantity held represents between six weeks and two months requirements. This means that, under normal circumstances, total stocks held amount to between 400 and 500 tons, most of which is located at various mills, whilst the remainder is kept in private warehouses, where rates are lower than those at the docks. Each major grinder, however, has his own policy regarding stocks. The combined purchases of pepper of the three largest account for about 80 per cent of total UK imports.

The largest grinder in the UK prepares annual sales forecasts for the following twelve months trading. These forecasts are adjusted after six months to allow for any discrepancies which may have occurred to the expected sales pattern. Stocks held at any period generally represent total expected sales over the next six weeks.

The second largest grinder attempts to keep stocks to a minimum at all times. On total imports of 1000 tons per annum, they buy forward no more than 200 tons at any one time, which means that actual physical stocks of pepper held at the mill probably do not amount to more than a maximum of 50 tons, or only two weeks requirements. This firm maintains its own representative in Djakarta, who, amongst other things, ensures prompt and regular shipments from origin thus enabling them to operate such a short stock position. The amount of money tied up in stocks is thus also kept to a minimum.

The third major UK grinder has no fixed stock replacement plan whatsoever. Substantial storage space is available to them and so they take full advantage of the fluctuating nature of pepper prices. Thus, they can hold anything between 2 weeks and 9 months requirements of pepper. This company is, however, the largest UK manufacturer of pepper oleoresin extract, and to ensure the supply of certain types of pepper that are only infrequently available, they will buy sufficient to fulfil their requirements for up to nine months ahead. As a company, they also have their own specific requirements concerning quality and content etc: they obtain fairly substantial quantities from Sarawak, packed to their own specifications. By maintaining strong links with growers in Sarawak and shippers in Singapore, they are better informed and therefore better placed to regulate their stocks in order to take advantage of changes in supply and price.

SOURCES OF IMPORTS AND MARKET PREFERENCES

An average of 3200 tons of pepper has been imported into the United Kingdom, per annum, over the last five years. At present, between 80 and 85 per cent of imports are of white pepper. Some five years ago, white pepper probably represented 90 per cent of the total; during the last few years, however, pepper has been increasingly used for the extraction of its oleoresins and essential oils for use in the food industry, and it appears that black pepper is widely used for this purpose.

The extent to which the increased use of pepper extracts may have affected total imports of pepper in recent years, is discussed under 'CONSUMPTION', in the United Kingdom section of this study.

Black pepper is also becoming more commonly used as a condiment in the home, due largely to the growing popularity of European and Oriental styles of cooking, which in general make more use of black pepper than white.

White pepper, however, is expected to maintain its dominant position in the United Kingdom market for some time, as, on the whole, it is much better known and, indeed, preferred by the consumer.

The United Kingdom obtains its supplies of pepper from three major sources: Sarawak, Indonesia and Brazil. Of total imports, between 70 and 80 per cent is from Sarawak. As it was formerly a British colony, many traditional links have been established between the pepper trade in the United Kingdom and producers in Sarawak. Some supplies are shipped direct from this source, but most enter the United Kingdom via the Singapore market. There is, however, a seasonal supply pattern, whereby imports direct from Sarawak begin to increase in May, as the new crop becomes available, building up to a maximum in July. During these three months, probably at least half of these imports are obtained direct, whilst throughout the rest of the year the vast majority is bought through Singapore.

Of total United Kingdom imports, at least 60 per cent is Sarawak 'fair average quality' (faq), which is available as both black and white pepper. It is still imported in substantial quantities because it is usually cheap enough, in comparison with other grades and sources, to allow the grinder sufficient margin to sift and clean it himself.

The quality of the pepper shipped is said by the trade to vary from season to season and from year to year. Many United Kingdom importers, therefore, would like to see much stricter grading standards established and enforced.

Two varieties of pepper are obtained from Indonesia; Lampong black and Muntok white. Muntok is considered to have extremely good flavour qualities, although some criticism is made of the condition in which it is shipped. Whenever it is available at source, the United Kingdom trade is, on the whole, very keen to buy. Lampong pepper is widely used as a source of pepper oleoresin.

Brazil has recently emerged as a major world source of pepper, most of its exports going to the United States. Its output has also had a considerable impact on European markets, including the United Kingdom. However, as can be seen in Table 1, quantities imported have varied in recent years (661 tons in 1969, 188 tons in 1970) but the overall trend has been upwards.

United Kingdom importers are unanimous in acknowledging the comparative cleanliness and good appearance of Brazilian pepper, notably the No 1 grade, which is the better of the two qualities available. The No 2 grade is only bought if there is a sufficient price differential to enable the grinder to raise its quality to that of the No 1 by sifting and cleaning it himself. The main advantage of best Brazilian pepper is that, very often, it can be ground or sold as it is, without requiring any further processing. The major drawback of this pepper, however, is that its aromatic and flavour qualities are considered inferior to those of pepper from either Sarawak or Indonesia, and, indeed, the flavour that it does impart is not liked by some United Kingdom users. This could mean that extractors and distillers, as their share of total United Kingdom pepper usage increases, might buy an even higher proportion of their requirements from South East Asia, as flavour characteristics are their prime consideration.

Many United Kingdom importers speak very highly of the quality of Tellicherry pepper from Malabar, in India. Supplies used to be obtained in significant quantities from this source, but in recent years almost all India's exports have been channelled into the Soviet Union under a mutual trade agreement. Small quantities are, however, still imported by specialist spice distributors, but prices are too high to attract bulk purchases from major grinders.

Small and intermittent quantities of pepper are also imported from Ceylon, Thailand, and other occasional sources. However, a grinder with specific orders to fulfil will sometimes be influenced more by the promptness of delivery of his purchases than by the particular grade or source of the pepper in question. This, however, applies mostly to food manufacturers who require fixed quantities to be delivered at set times. Most food manufacturers, however, buy their requirements from grinders, although a few still import pepper themselves. Nevertheless, of total purchases made by the major grinders in the United Kingdom, up to 20 per cent are 'spot' purchases (for immediate delivery), whilst a further proportion is bought 'prompt' (delivery within one month from anywhere in the world, or two weeks from Europe).

Price, however, is normally by far the most important single factor in determining from which source an importer will obtain his supplies, and which grade he will buy. Changes in price are almost entirely responsible for the violent fluctuations in quantities imported into the United Kingdom from year to year from any one source. Thus, imports direct from Indonesia, for example, amount to 661 tons in 1969, but only 41 tons in 1970; Brazilian imports amounted to 188 tons in 1970 and 666 tons in 1971; from Sarawak, 2213 tons in 1964, 505 tons in 1969.

Price can also determine the method of purchase adopted by a grinder. As discussed earlier, pepper can be bought in one of several ways; through a broker, from a dealer, from other importers or users, or direct from the country of origin. Many markets are also available, such as those in Singapore, London, Hamburg or Rotterdam. All the major importers in the United Kingdom keep a constant watch on price developments within the world pepper market, and always try to buy at the best price and in the cheapest market available.

A very few specialist importers will only buy pepper of a specified grade from a particular source, and certain oleoresin extractors sometimes require one particular kind of pepper in order to produce a certain flavour; but for the most part price is the dominant factor in determining buying policy.

DISTRIBUTION

In the United Kingdom, as in the other countries considered later in this study, grinders play the dominant role within the distribution pattern for pepper.

As stated earlier, 95 per cent of United Kingdom pepper imports go to specialist spice grinders, of which only six are significant. Three of these account for almost 80 per cent of the total.

Of these three companies, the largest concentrates its activities on supplying whole and ground pepper to the food manufacturing industry and to oleoresin and essential oil extractors. Another grinds and packs most of the 'own label' brands of spices marketed by the major retail supermarket chains; it also produces ground pepper for the food industry and manufactures various pepper oleoresins. The third grinder's major activity, accounting for 75 per cent of its output, is extraction and distillation. This company, indeed, is by far the most important producer of spice extracts and essential oils in the United Kingdom.

The food manufacturing sector

The largest sector, in terms of annual consumption, of the United Kingdom market for pepper (including oleoresins and essential oils) is the food manufacturing sector, which absorbs between 65 and 70 per cent of total United Kingdom imports. All the major importer/grinders sell a substantial proportion of their pepper to food manufacturers.

In addition to the two extractors mentioned above, there are several other smaller companies in the United Kingdom that also produce spice extracts. These firms obtain their supplies from other grinders and sell their products to food manufacturers.

Both pepper oleoresins and essential oils are available as individual products, but are almost always bought ready mixed with other spice or herb extracts to the buyer's specification. Oleoresins are sold dispersed onto a sterile base, such as salt or dextrose; for sausage and pie manufacturers a rusk base is also available.

Almost all the major United Kingdom food processors and manufacturers now buy some, if not all, their pepper requirements in the form of oleoresins or essential oils, and these particular products, although estimates vary considerably, probably account for about 60 per cent of all sales of pepper to major users within the industrial sector. This proportion, however, is still believed to be increasing. Indeed, one large American company is about to open a substantial new extraction plant in Derbyshire. Although there are several companies presently engaged in spice extraction and distillation, this industry is dominated, as mentioned earlier, by one company; it alone accounts for at least 60 per cent of total United Kingdom production.

Until a very few years ago, many of the larger food product manufacturers imported pepper themselves, which they then ground and used. With the increasing use of oleoresins and essential oils, almost all these firms now obtain their supplies from specialist extractors, and only one food manufacturer was found that still imports supplies of pepper itself.

The retail sector

This sector probably accounts for about 20 per cent of United Kingdom pepper imports. By far the most important retail outlets for pepper in the United Kingdom are the major supermarket chains, which together with consumer co-operative societies and voluntary chains of independent grocery outlets, account for about 75 per cent of total retail pepper sales. In recent years, there has been a tremendous growth in the number of 'own label' brands of grocery products, including spices, and most of the retail groups mentioned above market their own brands of pepper. In almost every instance, the packing of these 'own label' brands is done by grinders, who sell direct to the various central buying organisations of the large groups. There is, however, one consumer co-operative society that used to import, grind and pack its own brand of pepper. This society has recently sold its spice mill to an established independent grinder, and now obtains its supplies of cleaned and ground pepper from that grinder, which it packs in its own packing plant. Two of the six major United Kingdom grinders also pack and distribute their own brands of pepper, mostly to independent grocery outlets via wholesalers, but the quantities involved are not very significant.

As well as the grinders, who process and pack about 75 per cent of the pepper sold through the various retail outlets, there are also a number of small independent packers who market and distribute their own brands of pepper. These companies obtain their supplies from various sources, but generally do not have grinding facilities of their own. They either buy ready cleaned or ground pepper from a grinder, or, if they are subsidiaries of foreign-owned firms, they are supplied direct by the parent company abroad. These packers tend to aim at the upper end of the retail market and concentrate on producing a high quality product. Sales are made direct to both supermarket chains and multiples, as well as to wholesalers who distribute to independent grocery outlets.

With the development of 'own label' brands, and the increasing importance of grocery supermarkets, to which grinders sell direct, the role of the wholesaler is becoming less significant in the overall structure of United Kingdom spice distribution. However, the "Cash-and-Carry" trade, within the wholesale movement, is in fact actually increasing in importance; total sales by this sector have increased from £344 million in 1968/69 to £707 million in 1971/72.

Thus, the most significant trend within the United Kingdom retail distribution pattern for pepper appears to be away from the traditional progression from grinder to wholesaler to retailer, and towards direct sales from grinders to multiple retailers on the one hand, and to cash-and-carry wholesalers on the other.

The catering sector

The catering trade obtains its supplies of pepper, which account for between 10 and 15 per cent of total United Kingdom imports, through the same distribution structure as does the retail trade. There is also a tendency in this sector for increasing sales to be made direct to institutional caterers by grinders, and one such grinder commented that this was his fastest growing market. Most independent packers and distributors also sell to the catering trade, both direct and via the wholesaling and cash-and-carry trades. One packer, however, with a high quality, high-priced product, has found that, with pepper, institutional caterers are very price conscious and much less concerned with quality.

PRICES AND MARGINS

London month-end price quotations for Sarawak white pepper and Sarawak black pepper are given in Tables 7 and 8 respectively. Those for Malabar black pepper appear in Table 9.

Spot prices current for these peppers on 19 July 1972 were as follows:

Sarawak white	53.15 new pence/kg
Sarawak black (special)	37.40 new pence/kg

On the same day, the price of Malabar black, for June/July shipment, was 49.21 new pence/kg.

As can be seen from the Tables, average annual prices have been rising consistently over the past three to four years for all three varieties of pepper. Malabar black, however, has risen in price far more substantially than pepper from all other sources, its annual average quotation having increased by 82 per cent between 1967 and 1971, from 29.16 to 53.04 new pence/kg. The average price of pepper from Sarawak has risen by 45 per cent over the same period.

One grinder's prices, for ground pepper in July 1972, were as follows:—
Natural — Minimum order: 25 kg

	£ Sterling per kg
Pepper, ground black	0.61
Pepper, ground white (lowest grade)	0.58
Pepper, ground white (highest grade)	0.71

Independent packers obtain most of their pepper supplies from grinders. There follows an extract from the current price list of one such packer, who distributes to both the retail and catering trades:

Retail — All packed in plastic drums and sold in cartons of 6 drums.

Type of pepper	Size of drum (ounces)	Price per carton £ sterling	*Suggested retail price per drum £ sterling
Black, whole Black, ground	1½ oz	0.75	0.16½
Black, whole Black, ground	2 oz 2⅛ oz	1.05	0.24
White, whole	2⅜ oz	1.32	0.29
White, ground	2 oz	1.18	0.26

* Price suggested to the retailer by the packer

Catering — All packed in polythene bags. (Pounds and Ounces)

Type of pepper	Size of pack	Price £ sterling
Whole Black	1 lb	0.60
Ground Black	1 lb	0.66
Whole White	1 lb 2 oz	0.99
Ground White	14 oz	0.80

Pepper is normally sold by retailers at one price, whether it is black or white, ground or whole. Retail prices can vary considerably: one-ounce drums of pepper may, for example, be retailed at 5 new pence in one outlet but at more than double this price in another.

In so far as margins are concerned, very little information is available concerning the United Kingdom market.

Most dealers and brokers thought that the reason why so many brokers had gone out of business during the years after the Second World War was because a margin of one per cent was no longer sufficient to allow them to operate. However, now that all dealing and broking in the UK is essentially undertaken by six firms, the average turnover of each will have increased. Thus, perhaps, it is not unreasonable to suppose that, as in both Germany and Holland, the average margin is in the region of one to two per cent.

The average margin made by grinders in the UK, however, probably lies somewhere between 5 and 10 per cent.

The margin obtained by UK wholesalers on pepper is about 10 per cent, whilst packers may work on about 15 per cent.

Retail margins on pepper, as with most other spices, tend to be higher than those on the majority of food products: this is because pepper is not a fast-moving item, and demand is inelastic. The margin normally taken by a retailer is 33 per cent.

CONSUMPTION

Table 16 in the statistical appendix contains details of pepper consumption in the United Kingdom, together with consumption projections to 1980. Both annual imports and per capita consumption have shown little change over the period 1960-71. The overall trend has, if anything, been slightly downwards, as shown by the figures relating to the fitted curve analysis. When projected forward to 1980, these reveal that this downward trend is likely to continue, although only to a very limited extent. The United Kingdom market is, therefore, unique, in that it is the only one of the European national markets considered in this study that is expected to contract, both in terms of annual imports of pepper and per capita consumption.

One factor which, in part, may explain the lack of any increase in annual pepper imports over the last ten years — even when taking into consideration the growth in population shown in Table 13 — is the increased use of pepper oleoresins and essential oils by the food industry. According to the major spice extractor in the UK, the flavour content of pepper oleoresin can be up to one third stronger than that of the pepper from which it is extracted. In this way, less pepper is required to produce the same amount of flavour. Thus, as more food manufacturers have turned to spice extracts for their flavour requirements in recent years, so the needs of the food industry, in terms of actual tons of imported pepper, may have declined.

In addition, in certain food manufacturing processes, oleoresins are easier to disperse evenly throughout a product and more effective in imparting flavour to the product than ground spices. For this reason, one major meat product manufacturer who has recently changed from ground pepper to oleoresins has found that, whereas previously they required an annual average of about 120 tons of ground pepper, they now only need about 100 tons of pepper equivalent in the form of dispersed pepper oleoresin.

However, since most major food manufacturers have already switched to spice oleoresins, the effect of this changeover in reducing imports may be less marked in the future, particularly as the market for convenience foods continues to expand.

The Federal Republic of Germany

ORGANISATION OF THE IMPORT TRADE

The commercial centre of the pepper trade in the Federal Republic is Hamburg. With London and Rotterdam, it is one of the three principal trading centres for pepper in western Europe and has a substantial transit trade. Imports of pepper into the Federal Republic are the largest in western Europe, averaging over 6,000 tons per annum in the period 1967-71. Virtually all this quantity passes through Hamburg, where the principal dealers and brokers are located, for subsequent distribution to grinders throughout the country. Pepper is traded on the No. 5 and No. 1 contracts of the General Produce Brokers Association of London.

Dealers

There are six spice dealers in Hamburg who together are estimated to account for about 90 per cent of the pepper traded in the Federal Republic. The turnover of pepper amongst these dealers far exceeds the 6,000 tons actually imported for domestic consumption. In addition to handling domestic imports, they are also trading with grinders in other European countries and with other dealers in the European speculative market. From information provided by the Hamburg trade, it is estimated that total trade in pepper handled by these dealers amounts, in round figures, to some 20,000 tons per annum. Some dealers tend to concentrate more on supplying the grinders, while others are more speculative.

Dealers are the main source of supply of pepper to grinders in the Federal Republic, selling either direct or through a broker. Dealers buy direct from origin, where a few have their own representative. One dealer, for example, trading only in spices, shares a representative in Indonesia with a firm of copra merchants. Some 80 to 90 per cent of this dealer's turnover consists of sales to grinders in the Federal Republic, Austria, Switzerland, Belgium and Scandinavia. He is understood to be the largest single supplier of pepper to grinders in the Federal Republic.

Dealers buy pepper on their own account for distribution to grinders. However, as mentioned previously in this report, the grinders are the actual importers since it is they who clear the pepper through port and customs procedures. If a dealer sells to another dealer he will do so normally through a broker, whether the transaction is with a Hamburg dealer or with one in London or Rotterdam, but there is believed to be direct contact between all the main European dealers, particularly since the main London dealers are also brokers.

The largest single dealer in pepper in the Federal Republic is, in fact, a broker. About 95 per cent of his trading is concerned exclusively with pepper. Since he buys on his own account as well as acting as a true broker, his business in pepper is similar to those London dealer/brokers who engage in the same type of trading and is primarily of a speculative nature. He supplies pepper to grinders in Hamburg but not elsewhere in the Federal Republic (the reason for this is explained later).

Another of the Hamburg dealers sells to grinders in Scandinavia, Austria, France and eastern Europe as well as in the Federal Republic, specialises more in Brazilian pepper, and is not greatly speculative. Trading in pepper accounts for about 35 per cent of his turnover (the balance being in other commodities). Of the tonnage of pepper which he handles, only about 25-30 per cent is sold in the Federal Republic, the remainder going to grinders in the other European countries named above. This dealer buys direct from Brazil, but for purchases of Sarawak pepper he normally goes through a broker or buys in the European speculative market; Indonesian pepper he normally buys through trading companies (one in Hamburg and one in Holland) who act as agents in Europe for Indonesian exporters. The pepper turnover of another of the main Hamburg dealers is almost equally divided among sales to German grinders, sales to grinders in Scandinavia and Austria, and trading in the European speculative market.

Brokers

There are 13 spice brokers in Hamburg but only about 5 or 6 are important in pepper trading. By far the most important of them is the broker/dealer referred to above. Although one or two others are also believed to speculate as dealers in a small way, their main business is the traditional function of an intermediary between buyer and seller, receiving a commission, normally one per cent, paid by the seller.

It is an accepted custom (though not necessarily fully adhered to by all brokers) that Hamburg brokers do not do business with grinders in "the interior" — i.e. elsewhere in the Federal Republic outside Hamburg — but confine their business dealings to grinders in Hamburg (this explains the earlier reference to the major dealer/broker restricting his sales to Hamburg grinders). The dealers sell direct to the grinders outside Hamburg. Hamburg brokers obtain information from origin and are in contact with dealers in the Federal Republic and elsewhere in the European trade.

Brokers provide a broad spectrum of information on the pepper market to their clients, which the dealers and grinders could not necessarily obtain themselves without a great deal of time and trouble. They do not have direct contact with Brazil because Hamburg dealers have their own connections there. Moreover, a Japanese company is said to be active in the financing of Brazilian pepper production. It has a Hamburg office which acts as the sole agency for the company's distribution of Brazilian pepper in the Federal Republic and other European markets, principally Rotterdam and Paris.

Grinders

The grinders are the central agencies for the distribution of pepper throughout the Federal Republic since virtually all the pepper consumed passes first through their hands.

Grinders buy pepper from dealers (direct or through a broker) or purchase direct from origin, but the bulk of the purchases are still obtained from dealers. There is an increasing tendency among larger grinders to purchase direct from origin but the majority still prefers to trade with the dealers. It is administratively simpler and more convenient, the purchases of smaller grinders would not warrant it and — more important — it is sometimes cheaper to buy in the European market. According to one of the large Hamburg dealers, pepper in the European market has tended to be cheaper than at origin for nearly two years now; since December 1971, as much as £30 per ton cheaper. Another of the major pepper dealers in Hamburg gave a specific example: Sarawak white, faq grade, £420 per ton, cif, June 1972, from origin, was being quoted in Hamburg for May/June at £412.

Some grinders specialise in sales to the food industry while others specialise in packing for household consumption through the retail trade. For the Federal Republic as a whole, there are about 12 grinders (6 selling mainly to the industrial sector and 6 to the retail sector) who together account for 80-90 per cent of the pepper distributed throughout the country. The major grinders are found in Hamburg, Bielefeld, Bremen, Dissen, Mannheim, Munich, Nuremberg, Osnabruck and Stuttgart.

The annual purchases of pepper of these major grinders generally range from about 250 tons to 500 tons, with one as high as 800 tons. This last grinder buys half his requirements direct from a shipper in Singapore in order to save on the dealer's 1-2 per cent margin. For purchases of 800 tons of pepper at a minimum average price per ton of, say, £400, the saving on the dealer's margin could amount to between £3,200 and £6,400 per annum. He does not buy all his requirements direct because prices are sometimes cheaper in the Hamburg market. He also buys direct from dealers in the Netherlands (and never goes through brokers). The pepper he buys from Singapore is Sarawak pepper, mostly white. In his opinion there is a trend towards buying direct rather than through a dealer.

The trend towards buying direct would seem to depend on the annual tonnage of pepper purchased by a grinder. Another grinder, with annual purchases of 300 tons, also buys half of this direct from Singapore. However, this is not always so: one grinder with purchases in excess of 300 tons per annum buys some direct from Singapore but most of it through Hamburg dealers. Nevertheless, it is reasonable to expect the development of a trend towards direct buying if the large grinders gain more experience and have more confidence in trading with origins.

Trade associations

The trade association which represents spice dealers and brokers in the Federal Republic is the Waren-Verein der Hamburger Borse eV, in Hamburg, which was founded about 1900. The spice section of the association has about 20 members, including all the main brokers and all but one of the major dealers. The function of the association is the customary one of furthering the trade interests of its members and representing their views to the Government on matters affecting those interests, such as taxes and general legislation. It also concerns itself with commercial and legal matters arising out of the European Economic Community inasmuch as they affect members' interests.

Spice grinders in the Federal Republic have a separate trade association — the Fachverband der Gewurzindustrie eV, with offices in Bonn. The association is a member of the federation of German food industries. The association represents the interests of its 83 members in a similar way to the Waren-Verein.

Import duties and taxes

Pepper imported into the Federal Republic is dutiable at 10 per cent *ad valorem* on the cif price. There is also a value added tax of 5.5 per cent.

STOCKS

The major stocks of pepper are held by the grinders. Dealers no longer carry large stocks for the purposes of speculation as the costs of holding them are too high. Stocks held by dealers in the free port of Hamburg at any one time are understood to be very small. The aim of the dealers is to sell pepper as quickly as possible — preferably before a vessel arrives — in order to keep costs at a minimum.

It would appear that grinders normally carry a stock roughly equivalent to 20 per cent of their annual requirements, though some of the very large grinders may carry as much as 25 or 30 per cent. Stocks tend to be run down when pepper prices are high and increased when prices are low. The unusually high imports of 1971 into the Federal Republic (7,000 tons) were said by dealers to be due to stock replenishing. Stocks had been run down due to the existence of a high bank rate.

There is some element of speculation in the stock-holding policies of some grinders and they will sell quantities to dealers from time to time.

SOURCES OF IMPORTS AND MARKET PREFERENCES

The import statistics for the Federal Republic show that the major sources of supply are Malaysia, Indonesia and Brazil, with smaller quantities from Singapore, India and Malagasy. Out of a total of 6,000 tons imported in 1970, 4,000 tons came from Malaysia, 800 tons from Indonesia and 600 tons from Brazil. No published figures exist to show the ratio of white to black pepper imported but information obtained from dealers and grinders suggests that the proportions are about 70 per cent white to 30 per cent black. The grades of black pepper imported are Sarawak Black Special (said to be equivalent to the former faq grade), Lampong Black faq, and Brazil No. 1 and No. 2 grades. In white pepper, the grades are Sarawak (Blue Label) and Muntok faq, Sarawak Green Label (normally expected to fetch a premium of £15-£20 per ton over Sarawak faq) and Brazil No.1 and No. 2 grades.

It is generally acknowledged that Brazilian pepper is the cleanest of all origins; the white pepper is a good colour, and the No. 1 grade can be sold as whole pepper without further cleaning. However, the flavour is not universally liked — it is blander than that of other origins and with a flavour which some consider unpleasant. Because of its good appearance, it is widely sold as whole pepper through the retail trade.

Muntok is the white pepper preferred by the industrial sector and also by most of the grinders serving the retail sector. Buyers will normally pay a premium for Muntok over Sarawak white faq but the extent of this depends on the price relativities. Grinders sometimes mix spices of different origins to improve colour and flavour. The factors normally assessed for quality are aroma, impurities, colour and size of berries. The large food manufacturers have their own quality control procedures and demand a high standard of quality from the grinders. Quality is also important for grinders who specialise in sales to the retail sector, particularly a grinder with an established brand name.

Although buyers may be prepared to pay a premium for certain grades and origins, price is the most important factor which influences their buying policy.

DISTRIBUTION

It has already been mentioned that the grinders are the focal point for the distribution of pepper to industrial users, wholesalers, retailers and institutional caterers throughout the Federal Republic. There are no recorded figures to show the proportions going to each sector and estimates have to be based upon the opinions of those familiar with the pepper trade. These would indicate that about 70 per cent goes to the industrial sector, 20 per cent to the retail sector and around 10 per cent to institutional caterers.

The largest single outlet in the industrial sector is the meat-processing industry, where pepper is used particularly in the manufacture of sausages; also in canned meat and meat-based convenience foods and snacks. The other main outlets in food manufacturing are in fish canning, soups and mixed pickles. Large quantities of pepper going to the meat industry do so in the form of mixed spices prepared by grinders to meet the industry's particular recipe requirements, and not in the form of pepper as pepper. Grinders normally sell direct to users in the food industry, while sales to the institutional catering sector normally pass through wholesalers. However, most pepper for consumption in the retail sector is distributed by the large food chains and co-operative buying groups. Some of these large groups have their own grinding and packing facilities and purchase their own pepper from dealers. (One large co-operative buying organisation buys some of its pepper direct from Singapore.) Some grinders pack for the private labels of the large food chains.

Pepper to the industrial sector is usually sold in 10, 25 and 50 kilogram packs within polythene liners, and sometimes in the original packing. Sales to the retail sector are packed in a number of ways: aluminium foil sachets, plastic jars and drums, glass jars, glass dispensers, aluminium-coated dispensers. The quantities in the retail packs normally range from 10 grams to 60 grams.

PRICES AND MARGINS

Dealers in the Federal Republic work on a margin of one to two per cent (one dealer in Hamburg said that some firms had ceased to trade in pepper because of high costs and the low percentage return from business with the grinders). The following table shows price movements of pepper in the Hamburg market in recent years, based on information supplied by a Hamburg dealer:—

Price movements of pepper in Hamburg

(Deutschmarks per kg, spot)

	Muntok/Sarawak White		Lampong/Sarawk Black		Malabar Black	
	High	*Low*	*High*	*Low*	*High*	*Low*
1960	11.34	6.03	7.31	3.81	7.19	3.85
1965	5.98	3.65	3.60	3.27	4.65	3.70
1969	6.30	2.70	4.10	2.00	6.00	3.10
1970	4.30	3.10	3.80	2.70	5.40	4.30
1971	5.00	3.60	3.70	3.00	4.90	3.60

Note: Prices for 1969 to 1971 are approximate to one decimal place.
Source: *Menke & Co. Hamburg.*

It was not possible to obtain information on margins because traders were, not unnaturally, reluctant to discuss the subject. However, the following table compares the import price of white pepper with selling prices at the grinder, wholesaler and retailer stages:—

Price spreads for white pepper

(Deutschmarks)

Pack	Unit (whole or ground)	Price cif (unground)	Price duty paid (10 per cent)	Grinder	Wholesaler	Retailer
Aluminium-coated dispenser	35 grams	0.12	0.13	0.54	0.65	0.90
Glass dispenser	60 grams	0.20	0.22	1.10	1.35	1.95

Note: The import price has been taken as £425 per metric ton, cif, July/August, from origin (Indonesian Muntok), for the purposes of illustration. The import price has been converted at a rounded exchange rate of £1=DM8.

As an example of the price at which grinders sell pepper direct to food manufacturers, one grinder quoted his prices for ground white Sarawak/Muntok, faq, as DM5 per kilogram for a minimum order of 25 kilograms and DM4.80 for a minimum of 50 kilograms. Grinders selling to the food industry will vary their prices in response to changes in the prices which they themselves have to pay.

CONSUMPTION

The statistical appendix contains full details of per capita and projected consumption of pepper in the Federal Republic of Germany. Apparent consumption has increased from 4,000 tons in 1961 to 7,000 tons in 1971, giving a per capita consumption in 1971 of 118 grams, the highest of the four countries reviewed in this study. It is projected that per capita consumption by 1980 should reach over 132 grams, representing a total consumption in the Federal Republic of around 9,000 tons.

During the Second World War the import of spices was restricted and controlled by foreign exchange allotment, and spices did not begin to be bought freely until about 1951. Consumption of most spices, including pepper, has continued to increase since then, assisted by the growth of the food industry and the introduction of a wide variety of convenience foods.

The only new form of pepper which has appeared on the market is the recently introduced green pepper, which consists of whole unripened pepper berries preserved in brine (mostly) or vinegar. Green pepper is at present obtainable from Malagasy and India, the former having introduced it to the market. A Hamburg dealer is currently importing cans from India. The advantage of green pepper is that the consumer can enjoy the benefit of the "real" pepper taste; with dry pepper the heat tends to mask the taste. However, imports into the Federal Republic are still very small (the exact quantity is not known) and although they may increase, the price of green pepper (retailing at DM3.50 per tin of 110 grams, net drained weight) makes it a luxury item.

The Netherlands

ORGANISATION OF THE IMPORT TRADE

The Netherlands is an important centre for pepper trading, particularly in respect of Indonesian pepper as a result of Dutch traditional ties with that country. There is a substantial transit trade in pepper through Rotterdam (and Amsterdam) but no figures are available to indicate the size of this trade; dealers and brokers considered it impracticable to try to estimate it.

Dealers

Five spice dealers are together estimated to account for nearly all pepper trading carried on in the Netherlands, but two of them are much more important than the other three. These two major dealers, with one of the other three, are together believed to account for as much as 95 per cent of the trading in pepper. The largest of the five dealers claimed that about 90 per cent of his pepper business was concerned with the transit trade.

Dealers are in direct contact with exporters at origin, and with other dealers in Europe. Business with European dealers is normally conducted through brokers, as are sales to grinders. Dealers claim that they work on a margin of about one per cent, taking their trading activities as a whole. They trade with origin on a Letter of Credit basis, whereas the buyer in Europe pays cash against documents. Dealers, therefore, maintain that they are facilitating credit for the exporters at origin. Pepper is sold by dealers on a cif basis and the buyers, ie grinders, clear the pepper through port and customs formalities and are, thus, technically, the actual importers.

Brokers

There are four important pepper brokers in the Netherlands: two specialise in servicing dealers and two in servicing grinders. The two concerned with dealers' trade negotiate business with dealers in Rotterdam, Amsterdam, Hamburg and London. They are not normally in contact with exporters at origin. It is possible that these brokers sometimes trade on their own account.

The two brokers whose main business is with the grinders do not deal in pepper, ie they do not trade on their own account but receive a commission, normally one per cent, from the seller. Brokers in the Netherlands also act as agents for exporters of commodities in other countries, though this is not so for pepper.

For example, one broker is sole agent in the Netherlands for paprika from Hungary. He transmits orders from Dutch buyers to the exporter in Hungary, from whom he receives a commission. These commissions from agency business are believed to form an important part of brokers' earnings.

Grinders

Five grinders are together estimated to handle about 90 per cent of the pepper consumed in the Netherlands; two of these would appear jointly to handle two-thirds or more of total Dutch consumption. One of these two claims a 55 per cent share of total sales of spices to the retail sector. All these five grinders buy pepper through brokers. Of the two largest, one does so exclusively, while the other, and one of the remaining three, makes some purchases direct from Singapore. The extent of these direct purchases was not disclosed but it would seem that, for one of the two grinders involved, the quantity could amount to about 50 per cent of his annual purchases of pepper. They buy direct if they consider it will be cheaper but the general view of grinders is that it is risky to buy direct from exporters who are not known to them. Buying through a broker provides some guarantees as to delivery and is administratively simpler. The smaller grinders, in particular, prefer to buy through brokers.

Some grinders speculate to a limited extent in that they will re-sell pepper, through a broker, to other grinders. However, in the context of total Dutch consumption, the quantities involved are probably not very significant.

Trade associations

The Netherlands spice trade association (Nederlandsche Vereeniging Voor Den Specerijhandel) has over forty members. The function of the Association is to promote the spice trade and its interests in the Netherlands and to protect its members against irregularity and abuses in the trade. For this purpose it issues articles governing the general conditions for trade in spices, relating to such aspects as quality, packing, shipment and arbitration. With regard to pepper, it is traded on the basis of the No. 5 and No. 1 contracts of the General Produce Brokers Association of London.

There is also an Association of Importers of Indonesian Produce (Vereniging Van Importeurs Van Indonesische Producten (VINIP)) to which some of those prominent in the pepper trade also belong. The general conditions for trade in spices referred to above are adopted in co-operation with the VINIP.

Import duties and taxes

There is an import duty of 10 per cent *ad valorem* on the cif price of pepper imported into the Netherlands and a value added tax of 14 per cent.

STOCKS

In former years it was common practice for dealers to hold stocks of pepper in Europe, mainly with a view to speculating on price movements, but it would appear that this is now rarely done. However, one large international pepper dealer in Rotterdam still, at times, holds stocks of 200 to 300 tons in bonded warehouses, though not on a regular basis. The costs of financing large pepper stocks discourage dealers from holding them.

Grinders carry stocks, mainly for their own requirements (small quantities may be sold through brokers to other grinders from time to time). Given the costs of holding stocks of pepper, mentioned above, grinders would seem to relate their stock position to the size of their business and hold about 20 per cent of their annual requirements as stock at any one time. One Dutch grinder holds stocks equivalent to two months' requirements. Another grinder – one of the two largest in the Netherlands – claims to hold about 20 tons on average in stock against annual purchases of close on 300 tons. This is much less than 20 per cent of annual requirements and may be an under-estimate on the part of the grinder or, alternatively, a measure for reducing the costs of his stock inventory. There is a tendency to increase stock levels when prices are regarded as favourable and to lower them when prices are less favourable. However, it seems fairly clear that grinders in the Netherlands do not carry stocks which would allow them to operate for more than about three months without replenishment.

SOURCES OF IMPORTS AND MARKET PREFERENCES

Imports of pepper into the Netherlands in the period 1967-71 averaged 900 tons per annum.

The import statistics show that the principal sources of supply to the Dutch market are, in order of magnitude, Indonesia, Singapore, Brazil and Malaysia. The actual quantities imported from each source vary somewhat from year to year but the percentage shares are of the order of 60 per cent from Indonesia, 20 per cent from Singapore, and 5-10 per cent each from Brazil and Malaysia. Small quantities are imported from European sources, mainly the Federal Republic of Germany. No imports are recorded from India. The price of Indian pepper is said to be too high for the west European market.

The pepper imported into the Netherlands is predominantly white. No official statistics exist which distinguish between the actual tonnages of white and black pepper imported, but information provided by the grinders supports the general opinion in the Dutch pepper trade that over 80 per cent of the imports consist of white pepper. Again, it is not possible to be exact about the proportion of total imports of white pepper obtained from the different origins, but trade estimates and grinders' purchases suggest that perhaps 50 per cent is Indonesian, 40 per cent Sarawak and 10 per cent Brazil.

It is generally agreed in the trade that Brazilian white pepper is the cleanest of all, but it is also pointed out that the flavour is less strong than that of other origins. Brazilian white pepper, because of its clean appearance, is generally sold whole in glass jars for the retail trade. One grinder, who specialises in sales to the retail sector, claimed to have purchased 40 tons of Brazilian white pepper in 1971 out of a total tonnage said to be imported that year of 62 tons. In terms of flavour, Indonesian Muntok is the preferred white pepper. The black pepper entering the Netherlands goes almost entirely to food manufacturers.

Allowing for preferences based on cleanliness and flavour, price is still the principal factor which influences the grinders; more so, since about 60 per cent of the pepper goes to food manufacturers in the form of mixed spices, and grinders will mix peppers of different origins to improve flavour and/or appearance.

DISTRIBUTION

All pepper imported into the Netherlands passes through the hands of the grinders and it is they who are the focal point for distribution to wholesalers, retailers, institutional caterers and food manufacturers. Some grinders specialise in supplying pepper for the retail sector while others supply mainly food manufacturers. Of the two largest grinders in the Netherlands, one is concerned mainly with sales for the retail trade and the other with sales to food manufacturers.

No figures are available to show the pattern of distribution of pepper among the three main consuming sectors — food manufacturers, direct consumption by households and institutional caterers. However, estimates given by grinders and others trading in pepper suggest that over 60 per cent goes to food manufacturers, about 30 per cent to households and not more than 10 per cent to institutional caterers.

Meat processors are the largest industrial consumers of pepper; other important consumers are soup manufacturers and fish canners. The production of sausages, luncheon meats, pies and canned meat foods generally is the most important use for pepper in the food industry. However, the pepper consumed by canners is mainly in the form of mixed (ground) spices, and not pepper as such, which tends to be confined to sausages and luncheon meats. Meat processors will sometimes provide the grinder with their own formula for a mixed spice and this will be made up and packed by the grinder. About 90 per cent of the mixed spices supplied to meat processors are sterilised after grinding (cold sterilisation process).

One grinder who specialises in supplying mixed spices to the meat processing industry is estimated to supply about 60 per cent of the pepper consumed by the industrial sector in the Netherlands.

Pepper, both in the form of mixed spices and as pepper itself, is sold direct to users in industry by the grinders and not through wholesalers. Pepper sold to industry is normally in 25 kilogram packs with polythene liners.

Direct consumption of pepper in households is the second largest outlet for pepper. This is distributed to the retail outlets almost entirely through the large food chains, co-operatives, and buying groups, the last representing large numbers of smaller retailers and acting as central buying organisations for their members. The largest food chain in the Netherlands, with about 500 retail outlets and a share of about 20 per cent of the Dutch retail grocery trade, has its own meat-products plant. About 30 per cent of the pepper it buys is sold through its retail outlets for household consumption (about 99 per cent white pepper); 90 per cent of the remainder (mainly white Muntok) is used by its own meat-products plant and the balance is sold to institutional caterers.

The large buying groups are supplied by the grinders; none is known to make purchases direct from origin or dealers or through brokers. Pepper for retail distribution is packed by the grinders in small tins (sometimes plastic jars) of 25 grams and 50 grams and also in glass jars of 30 grams (ground) and 40 grams (whole). The largest grinder specialising in sales to the retail sector packs 10 million units of spices (all pack sizes) a year, of which about 4.5 million units are 50 gram tins (sales of the 25 gram tins were said to be declining each year). Of these same 10 million units of spices, 2.8 million are packed for private labels for the large retail food groups such as the one referred to above. Sales of pepper, of course, make up only a minute fraction of the total turnover in food wholesaling and retailing.

Sales of pepper to institutional caterers, mostly in ground form, are normally distributed by the grinders in packs of 500 grams, 1, 5 and 10 kilograms, either direct or through one of the large wholesale food groups.

PRICES AND MARGINS

Information on margins can only be approximate due, on the one hand, to the reluctance of businesses to disclose such information and, on the other, to the sometimes wide variation in figures quoted as representative. Dealers claim to work on an overall trading margin of one per cent. Although this must vary from time to time, depending on market conditions, it is at least indicative of the order of magnitude. Brokers receive a commission of usually one per cent, paid by the seller. The margins of the grinder, wholesaler and retailer are more difficult to establish exactly. However, it would seem that the grinder's margin is in the region of 10 per cent (one grinder maintained it was only 5 per cent), as is the wholesaler's, while the retailer's is 25 to 30 per cent.

The following table compares the import price of white pepper (Indonesian Muntok, £425 per metric ton, cif July/August, from origin) with the selling prices at the grinder, wholesaler and retailer stages, based on information supplied by Dutch grinders. [Prices are in guilders: the import price has been converted at a rounded exchange rate of £1 = 8 guilders.]

Price spreads of white pepper

(guilders)

Pack	Unit	Price cif	Price duty paid (10 per cent)	Grinder	Wholesaler	Retailer
Tin	50 gms, ground	0.17	0.19	0.70	0.81	1.21
Glass jar	30 gms, ground	0.10	0.11	0.80	0.93	1.40

The grinders usually sell pepper of different origins to food manufacturers at prices which take account of the difference in price of the separate origins, but for the retail sector pepper from all origins (white Sarawak or Indonesian or Brazilian) is sold simply as "white pepper" at the same price. Therefore, although the grinder has to face price fluctuations and yet try to maintain a reasonably stable price to customers, he can offset this to some extent by averaging prices for all origins. The large customers of the grinders (food chains etc.) place contracts with them for one year at a fixed price. Grinders have to clean and sift the pepper before grinding and losses in grinding may amount to 2-5 per cent, with an average of perhaps 3 per cent.

CONSUMPTION

The statistical appendix contains full details of per capita and projected consumption of pepper in the Netherlands. Apparent consumption of pepper has increased during the decade; from an average of 600 tons per annum in the period 1962-66 to 900 tons in 1967-71. Per capita consumption has also shown an upward trend and in 1971 amounted to 75 grams. It is projected that this will stand at over 100 grams by 1980 with a total consumption for the country as a whole of around 1600 tons.

Consumption of spices as a whole has increased since the Second World War for reasons which are now familiar; increased travel to foreign countries stimulating an interest in a wider range of foods; the growth of convenience foods. However, pepper is a basic, every-day, spice and some others have shown more marked increases. There is no evidence of any new uses for pepper in the Netherlands which are likely to stimulate pepper consumption.

France

ORGANISATION OF THE IMPORT TRADE

The pepper market in France differs from those of the other countries considered in this report in that it is essentially non-speculative. The basic function of those active in the import trade is, therefore, to provide supplies of pepper for the needs of the domestic market. There is no significant transit trade between France and other European markets.

Dealers

Since France is basically a terminal market for pepper, apart from small quantities that are sold on to users in certain North African countries, there are no dealers of any importance active within the market. Thus, in order to obtain supplies of pepper, a French importer has two options open to him; either to use the services of a broker, or to buy direct from the country of origin.

Brokers

Of total imports of pepper entering France, about 80 per cent are obtained through the services of a broker. Three broking firms dominate the market and account for more than 90 per cent of the business. Unlike certain brokers in the United Kingdom, Germany and the Netherlands, these companies do not act as dealers (i.e., taking positions in the market on their own account), but always perform the traditional broking role of bringing seller and buyer together, for which they obtain a commission.

French brokers will arrange sales of pepper to domestic users from one of three sources, namely, the European trade, the Singapore trade or the country of origin. About 55 per cent of purchases of pepper contracted through brokers in France are obtained from sources within the trade in Europe. As pointed out in the introduction, the major European centres of the pepper trade are Rotterdam, Hamburg and London, and it is in this order that they are important as sources of supply for users in France.

French brokers obtain most supplies of Indonesian and Sarawak pepper from two sources, either Rotterdam or London. Those which are obtained through dealers in Rotterdam have usually been shipped direct from origin, whilst those obtained through the London trade have normally come from Singapore.

Most imports of Brazilian pepper are bought from dealers in Hamburg. French brokers are also in contact with suppliers in Singapore, obtaining about 10 per cent of their turnover direct from this source. Links are also maintained between brokers in France and certain producing countries, and about 35 per cent of all pepper obtained through French brokers is understood to be purchased direct from the country of origin. Between 75 and 80 per cent of pepper imported into France in this way is obtained from Malagasy, now an associate member of the European Economic Community (EEC).

Brokers in France will, whenever possible, try to channel their business through the European trade rather than deal with a trader in Singapore. It was pointed out in this connection that any disputes could be settled much more easily, documents exchanged more speedily and arbitration proceedings set in motion more quickly when dealing with the European trade. The major brokers and dealers in Europe are highly competitive with one another and, in order to maintain their individual reputations, they are diligent in providing an efficient and reliable service to their clients.

Grinders

There are six major pepper grinders in France. Five of these firms specialise in grinding, packing and distributing pepper to the food industry, the catering and the retail trade, while the sixth is a food manufacturer. Between them, these firms import more than 80 per cent of total French pepper requirements. The remainder passes through the hands of a number of small specialist grinders and food manufacturers.

Of pepper imported by the major grinders, about 80 per cent is obtained through brokers, and 20 per cent imported direct from the country of origin (the bulk of which, as pointed out earlier, is from Malagasy). Amongst the smaller grinders, however, only about 2 per cent of their total imports are bought direct, whilst 98 per cent is obtained through brokers. Thus it would appear that the larger the importer, the more he will try to buy direct from origin. This conclusion is supported by the fact that the biggest grinder in France buys approximately 30 per cent of his annual requirements direct from pepper producing countries, considerably higher than the average proportion. All imports into France, other than those obtained at origin, are bought through a French broker, as grinders do not deal direct with the trade in other European markets or with Singapore.

Although there has been a recent tendency amongst certain major French importers to try to obtain a greater proportion of their supplies straight from the countries of production, so by-passing the brokers, such a policy can have its disadvantages. By so doing, an importer will tend to lose the goodwill of the broking community, which under normal circumstances provides him with a source of very useful information about prices, the availability of supplies and the like.

Generally speaking, however, most importers prefer to make use of the services of a broker. Although the broker's commission of one per cent is actually paid to him by the seller, it is effectively included in the price at which business is concluded between buyer and seller, through the broker. However, it is considered worthwhile by most buyers to incur a small premium in this way, as contracts entered into with someone on the spot are more easily dealt with than those with a distant grower or shipper. Moreover, the broker assumes complete responsibility for ensuring the performance of the contract on the part of the supplier.

By far the most common forms of contract employed by the trade in France are Contract Numbers 1 and 5 of the General Produce Brokers Association of London (GPBAL). As pointed out in the introduction, these particular contracts are generally adopted throughout Europe for importing pepper. One of the clauses, which appears in both contracts and is particularly favoured by French importers, requires that any dispute be settled by arbitration in London according to the rules of the GPBAL: London is considered to provide the most equitable courts of arbitration.

One major grinder in France did, however, comment that there were certain modifications in respect of the Number 5 contract which he considered long overdue. Firstly, he wished to see the contracted date of shipment refer to only one month instead of two, as at present. Secondly, he considered that the month of arrival of pepper should be contracted by the seller, as well as the month of shipment. He suggested that no great hardship would be involved by including such a clause, as there are several fast and frequent shipping services available to exporters to and from almost all parts of the world. He thought that the incorporation of both clauses would allow importers to adopt more regular buying policies which should, in theory, benefit both the producing countries and their customers, and would instil greater confidence on the part of importers when buying direct from origin.

Other forms of contract in use in France include a cif contract drawn up in Malagasy for use when importing direct from that source. Brazil exports only on fob terms, for which it has its own contract, although most imports of Brazilian pepper enter France via the European trade on a cif basis, and so this is of limited importance. (When the Brazilian fob contract is employed, it stipulates payment in US dollars.) Cambodia also has her own cif contract, which was very important in the past because Cambodia was the major source of French pepper requirements. Now, however, virtually no pepper is available from this source, consequently the contract is hardly used.

Contracts to supply a French importer with pepper are almost invariably drawn up "cif French port". There are certain "ports de base", or base ports to which pepper from various origins is usually shipped. These are as follows:

Origin	**Base Ports**
Sarawak, Indonesia and Singapore	Marseilles, Le Havre and Dunkirk
Brazil	Le Havre, Bordeaux and Dunkirk
Malagasy	Marseilles

There is usually a surcharge imposed for delivery to a port other than one of the base ports shown above for a particular origin. Thus, it can cost up to US $25 per ton extra to have pepper shipped from Brazil to Marseilles, rather than to Bordeaux.

Pepper that has already been landed in a European port outside France is charged per ton for shipment to a French port of the buyer's choice. There are no established scales of charges made, but such shipments tend to be very expensive. For example, a broker in Marseilles was quoted £45 per ton to ship pepper, originally bought by a London dealer from Singapore, from London to Marseilles. This was almost certainly more than the amount charged to ship the same pepper from Singapore to London.

Almost all pepper imported by the major French grinders is bought for shipment up to three months ahead, and is actually delivered between three and four months after the order is placed. About 95 per cent of this pepper is for the grinders' own individual needs, whilst the rest is for selling on, in the original bags, to other smaller grinders, most of whom buy a proportion of their supplies from their larger counterparts. When sales are made in this way, the major grinders are, in a sense, carrying out the functions of a dealer. Quantities traded in this way are minimal, however, probably amounting to rather less than 200 tons per annum.

Trade associations

There are three trade associations in France representing the pepper trade, and most French pepper brokers and importers belong to one or other of them. There is one in each of the three main centres of the pepper trade, namely, Paris, Marseilles and Bordeaux, and all three are represented by a union of spice trade associations in Paris, called the "Union Interprofessionnelle du Poivre et des Epices" (UIPE).

The Union was formed in the early 'fifties for two main reasons: firstly, to unite the trade after the disruption caused by the war and, secondly, to enable pepper importers to obtain supplies from countries other than ex-French territories and colonial sources. Before the formation of UIPE, it had been the policy of the French Government to allow imports of pepper into France from colonial sources only (almost all supplies were obtained from Cambodia and Madagascar at that time.) This was in order to protect these countries from competition from other producers, most of whom were able to offer their pepper at considerably lower prices. Eventually, however, supplies from these sources could not keep pace with increasing French demand, and so a system known as 'jumelage' was introduced, whereby an importer who bought a certain quantity of pepper from a francophone country was then permitted to buy a proportional amount from any other source. In order to be allowed to import pepper from the cheaper sources in this way, a government licence was required, and this was only given to accredited members of a recognised trade association. UIPE was thus formed by the various trade associations in order to apply to the Government for licences, to keep a record of all imports of pepper made by the members of the associations, and to provide information to importers on prices and availability of supplies in all the producing countries and overseas trading centres. The idea of this system was to ensure a secure market in France for pepper from Cambodia and Madagascar, at the best possible market price, whilst at the same time allowing importers to make up their requirements with cheaper pepper from elsewhere. With the eventual independence of both of these major suppliers, the Government finally agreed to abolish the system and allow unlimited imports from any source (although both Cambodia and Malagasy still benefit from exemption from the ten per cent import duty imposed upon imports of pepper into France).

With this change in import regulations, UIPE lost much of its importance, as it then became possible for anyone to import pepper, whether or not he was a member of a trade association. The Union, however, still provides certain useful services to the members of its affiliated trade associations. These can be summarised as follows:

1. The publication of a monthly pepper bulletin containing statistics relating to import quantities, origins, prices, dates of shipment and expected dates of arrival, together with occasional notes on overseas markets.

2. Assistance in ensuring the performance of contracts entered into with overseas suppliers. The Union will act on behalf of any member in instigating arbitration procedure over any legal disputes that may arise.

3. The provision of a focal point for members of the pepper trade, enabling it to act as a unified body in legal, economic, fiscal or other matters affecting the trade.

As stated earlier, almost all French brokers and importers are members of a trade association. However, the extent to which UIPE is representative of the French pepper trade as a whole has significantly diminished in recent years, owing to the fact that the second most important grinder in France is not a member of a trade association. This particular company only started importing pepper after the government restrictions on such imports were abolished, and consequently was not required to join such an association in order to obtain a licence.

Import duties and taxes

Although there are no quantitative restrictions imposed on imports of pepper into France, and importers are free to obtain supplies from any source, several internal taxes are levied on this commodity, together with an overall import duty.

Imports from all French ex-colonial countries, and overseas territories which have associate membership status with the EEC, enter France duty free. Pepper imported from all other sources attracts a flat rate duty of 10 per cent *ad valorem,* except those imports obtained by distillers specifically for the purpose of extracting essential oils and oleoresins, which enter duty free.

In addition to the actual duty, there is a Customs Stamp Tax, paid at 2 per cent of the total duty payable. An Interior Consumption Tax is levied at a standard rate of 43 francs per 100 kilogrammes on all imports of pepper for further processing or consumption in France.

Value Added Tax is charged at the rate of 7.5 per cent on the total value of the sum of the cif price plus the Import Duty plus the Interior Consumption Tax.

Finally, a Remittance Tax is levied at the rate of one per cent of the sum of the amounts payable under the Customs Stamp Tax, the Interior Consumption Tax and the Value Added Tax.

STOCKS

Since there are no actual pepper dealers in France, who in other countries might hold stocks of pepper for speculative purposes, the only people that hold significant quantities are the major importer/grinders. Almost all of this pepper is held for the particular grinder's own individual needs, and amounts on average to between two and three months supply, or between fifteen and twenty-five per cent of annual turnover. In actual tonnage, therefore, total stocks of pepper held at any one time by the three largest grinders in France, who together account for about 75 per cent of total French imports, is probably between 600 and 700 tons. A certain amount is also held in bonded warehouses at Marseilles and Le Havre. Total stocks held at these two ports amount on average to between 150 and 175 tons. All this pepper is actually owned by French grinders, and the bulk of it is simply awaiting collection by them. Small quantities, however, may also be for re-export, mostly to North Africa.

Smaller grinders tend to hold a smaller proportion of their annual requirements as stock. This is because they normally obtain a percentage of their needs from other larger grinders, which they buy only as and when it is needed. Indeed, one small grinding firm buys almost all its supplies from large grinders (amounting to 100 tons per annum) and, consequently, holds a maximum of about 5 tons of pepper at any one time, or only 5 per cent of its total annual needs.

The extent to which stock levels change with fluctuations in the price of imported pepper is minimal in France. Of the three major grinders, two stated that they kept rigidly to their predetermined stock replacement plans no matter what changes occurred in pepper prices. The third, however, commented that he would buy up to 10 per cent more than his requirements warranted during periods when prices were low. He would then carry this forward as surplus stock, to be used up when prices moved higher.

SOURCES OF IMPORTS AND MARKET PREFERENCES

Annual imports of pepper into France have amounted to an average of just over 4,000 tons over the last five years. According to figures published by UIPE in 1970, 70 per cent of imports in 1969 consisted of black pepper, and 30 per cent of white. According to figures obtained from French grinders during the preparation of this study, almost exactly the same proportional relationship exists in 1972, although some fifteen years ago only between 5 and 10 per cent of total imports were of white pepper.

There is in France, however, a distinct pattern of geographical preference between black and white pepper and, indeed, between whole and ground. In the south-west of the country, most pepper is used in making pâté de fois gras, and the numerous and various other local "pâtés de campagne", for which the region is famous. Whole black pepper is predominantly bought for this purpose: it is used either as it is, or is ground by the individual or company making the pâté. In the north-east, however, a far higher proportion of sales are of ground white pepper, which is bought by housewives at the local épicerie or supermarket for use as a condiment at the dinner table. This pattern can be best illustrated by an analysis of figures obtained from the major pepper grinders serving the two areas in question. Of total sales made by the three important grinders in Bordeaux, 85 per cent is black pepper and only 15 per cent white: only one third of the total output of these three firms is ground. By comparison, of the turnover of by far the largest grinder in Paris, whose sales catchment area is focused upon the Paris region and the cities of north eastern France, only 60 per cent is black, whilst 40 per cent is white: moreover, 60 per cent of total sales are of ground pepper, twice as much as in the Bordeaux area.

More than 95 per cent of France's pepper imports are obtained from Brazil, Sarawak, Malagasy and Indonesia. The remainder is made up of very small quantities from such sources as Ceylon, French Guinea, Cameroun, India, Cambodia and North Vietnam.

In 1971, of total imports of 4,566 tons, 2,236 tons, or almost 50 per cent, came from Brazil. Both black and white Brazilian pepper is available in two grades, No. 1 and No. 2. The bulk of imports into France consists of No.1 grade black. The advantage of this pepper, both over the No.2 grade and pepper from any other source, is that it is much cleaner. This often means that it can be sold by an importer to, say, a food manufacturer, in the unopened sacks in which it was imported, without requiring any further processing whatsoever. It is also well liked in France because the berries are larger and more uniform in size than pepper from any other source, which gives it an attractive appearance. The flavour is considered rather too bland by some importers, however, although for most the good appearance and presentation outweigh this drawback. The No. 2 grade is not bought as consistently as the No.1, or in such large quantities, as it invariably has to be cleaned before it can be sold whole, although some is ground in the condition in which it arrives. However, if the price falls to between 10 and 15 per cent (about US $50) below that of the No.1 grade, most importers will buy it, as this will give them a margin sufficient to cover the costs involved in cleaning and repacking.

In 1970, Sarawak was France's major source of pepper. Most imports from this source are of the Special grade, as grinders in France like to be able to grind pepper without cleaning it first, and the faq (fair average quality) grade is considered to be far too full of dust and foreign matter to be able to do this. The faq grade is also said to contain a high proportion of broken grains, and the black variety includes quantities of white grains. Thus, even when it has been cleaned, it is generally not considered suitable for retail sale as whole pepper. French food manufacturers and distillers both like the aroma and flavour qualities of black Sarawak pepper, and most sales of the Special grade are made to these users. As pointed out earlier, most pepper from Sarawak is obtained through the Singapore market.

Muntok pepper, from Indonesia, is generally considered to be the best white pepper available, in terms of quality. The grades available are faq and ASTA (which is packed to meet standards established by the American Spice Trade Association). French grinders consider that the ASTA grade is only marginally better than the faq. Both are usually slightly cheaper than white No. 1 grade pepper from Brazil. The Brazilian pepper, however, tends to be cleaner and of a better appearance than the Muntok. For these reasons, Muntok is usually bought for grinding, or is cleaned and sold whole to speciality food product manufacturers, whereas the Brazilian white pepper can be sold on, or repacked for the retail trade, as it is.

Cambodia used to be the most important supplier of pepper to France. As it was once a French colony, it benefitted not only from the Government's policy of disallowing imports from all non-colonial sources, but her exports were also exempt, as a colony, from import duty. However, owing to the recent political disturbances in the area, supplies from this source have been increasingly difficult to obtain, and exports to France fell from 475 tons in 1970 to 66 tons in 1971. Indeed, one major French broker has been unable to obtain any pepper from Cambodia since the middle of 1971.

Following the decline in importance of Cambodia, Malagasy emerged as France's major supplier towards the end of the nineteen sixties. Malagasy, having also been a French colony since 1896, has always been a traditional source of supply, and still enjoys exemption from duty on her exports of pepper to France. All pepper from this source is black, and its qualities of flavour are much extolled in France. According to several grinders, however, the condition in which it is shipped has been falling off markedly in the last couple of years. Its price has also been increasing to the extent that quantities imported into France fell from 1,903 tons in 1969 to 640 tons in 1970, and then to only 451 tons in 1971, losing its place as France's major supplier.

Because of this decline, a new conditioning plant has been put into operation in Malagasy in order to improve the quality of exported pepper. It has also been reported that two separate grades have been established, but it appears that the benefits of these developments have not yet been noticed by French importers.

DISTRIBUTION

More than 90 per cent of the pepper entering France is imported by grinders who clean, grind, pack and distribute it to various users throughout the country. Food manufacturers import the bulk of the remainder for use in their own food products, whilst very small quantities are imported by distillers for extraction purposes.

All the major grinders concentrate their activities within two market sectors, namely the food manufacturing industry and the retail trade. (In considering the French market, sales by grinders to distillers, amounting to a maximum of 200 tons per annum, have been included in figures relating to the food industry as a whole.)

The sales pattern of the four most important grinders in France, who together absorb about 80 per cent of total French imports, is as follows:

Retail Sector	65 per cent
Food Manufacturing Sector	30 per cent
Catering Sector	5 per cent

Smaller grinders, on the other hand, sell hardly any pepper to the food manufacturing industry, most of their output going both direct and via the wholesale trade to caterers (including charcuterie shops, which prepare and sell ready-to-eat dishes to the public), and the remainder to the retail trade.

Thus, for four minor grinders, the overall sales pattern was found to be as follows:—

Catering Sector	58 per cent
Retail Sector	40 per cent
Food Manufacturing Sector	2 per cent

Taking these two groups of grinders together, and including imports made by certain food manufacturers, the pattern of sales that emerges for France as a whole is as follows:—

Retail Sector	55 per cent
Food Manufacturing Sector	30 per cent
Catering Sector	15 per cent

Food manufacturing sector

This sector of the French market accounts for 30 per cent of total sales by the grinders. Over the last five years, this represents an average annual consumption of about 1,200 tons. Between 85 and 90 per cent of this is obtained direct from pepper grinders, whilst the remainder is imported by one or two very large food manufacturers themselves, via the services of a broker.

Retail sector

Average annual sales of pepper by the retail trade are currently running at about 2,200 tons, i.e., about 55 per cent of total imports. Thus, in France, this is the most important sector, whereas in all the other countries examined in this study the food manufacturing sector is the largest.

About 25 per cent of retail sales are by supermarkets and multiple retail groups, all of whom obtain their supplies direct from, and ready-packed by, the grinders. 'Own label' brands of pepper, marketed by a particular supermarket chain or retailing group, are not significant in France. All the major grinders have their own brand name, and all except one pack only under their own label. Considerable amounts of money are spent on promotion as competition between grinders within the retail sector is particularly fierce. One such grinder mounted a national television advertising campaign in 1971 to promote his brand name with an offer of three jars of pepper for the price of two. He commented that this was the first ever television advertising to appear in Europe for pepper.

Of the remaining 75% of retail sales not handled by large multiple grocery chains, about half is sold direct by grinders, both large and small, to local co-operative groups and independent retail outlets. The rest passes through the hands of wholesalers, whose sales are mainly to the smaller independent grocery stores.

Catering sector

As mentioned earlier in this section of the study, an estimate of sales to charcuteries has been included in total usage of pepper by the catering sector. The sector as a whole uses in the region of 600 tons per annum, or 15 per cent of total pepper consumption.

About half the catering trade's supplies are obtained through wholesale spice merchants, the remainder being bought direct from grinders, mostly the smaller ones.

PRICES AND MARGINS

There are two distinct pricing policies adopted by most French grinders for selling pepper. One applies to sales of ready-packed pepper to the retail trade, and the other to sales of bulk-packed pepper to the industrial sector. Prices, set by grinders for drums or jars of pepper bearing their own brand names, and which are sold to wholesalers and retailers, are established at fixed levels for long periods of time. They will only change if the average cost of imported pepper becomes consistently higher, or lower, over a period of several months, or if a major competitor changes his prices. Prices of bulk-packed pepper to the food manufacturing industry normally change each month, in proportion to fluctuations in the average import price of pepper during the preceding two or three months, depending on the individual grinder's buying policy.

So far as margins are concerned, the following information was obtained from those active in the market on the various levels through which pepper passes. Dealing by specialised traders in France is, to all intents and purposes, non-existent. The larger grinders will, however, on occasion, buy slightly in excess of their own needs if they anticipate that orders will be forthcoming from smaller grinders. In the same way, the smaller grinders will sometimes accept orders for pepper in the sack from customers, even if they do not actually have the pepper to sell. In the latter case, the grinder will then, to fulfil such orders, try to buy pepper at a lower price than he has agreed to sell it, thus, in effect, carrying out the function of a dealer. The minimum margin acceptable to sellers in transactions of this nature was found to be about 7 per cent, and the usual range obtained was between 7 and 10 per cent. As pointed out earlier, however, quantities traded in this way are minimal, amounting to but a few hundred tons per annum.

Margins on bulk sales to the food industry are normally between 2 and 5 per cent. Margins on sales to wholesale spice distributors – who in turn pack and supply most of the needs of caterers as well as many of the smaller independent retail outlets, and who are sometimes small grinders themselves – tend to be of the order of 5 to 10 per cent.

On pepper that is ready-packed by the grinders for retail sale, margins are higher, ranging from 15 to 25 per cent. Most grinders sell retail containers at one price, whether they contain ground or whole pepper, black or white. Thus, since black pepper is cheaper than white, the profit on selling whole black pepper is higher than on ground white.

None of the grinders or packers encountered in France gives quantity discounts on sales of pepper, either to the retail trade or to the food industry. As in the United Kingdom, for example, retail margins on spices tend to be higher than on most other grocery products. The vast majority of retail sales of pepper are of small plastic or tin drums, or glass jars, containing between 15 and 50 grams of spice. Retail margins on these products are normally between 30 and 40 per cent.

Some specialist epiceries sell pepper loose, by the 100 grams. Margins on this type of sale normally vary between 80 and 100 per cent. Quantities sold in this way, however, are extremely small.

Margins on green pepper, a luxury and rather exotic product, also tend to be very high, in the order of 60 to 75 per cent, although, as with loose pepper, the amount sold is very limited.

Three tables follow. The first shows import prices of pepper from various origins between 1964 and 1971; the second, the effective price of one kilogram of pepper when packed in various ways, as sold by a grinder in Bordeaux; the third, a list of actual prices at which various retail packs of pepper are available in French shops.

Average cif import prices of pepper entering France 1964-1971. Shillings per cwt

	Origin	1964	1965	1966	1967(1)	1968	1969(2)	1970	1971(3)
White	Sarawak faq	300/-	326/9	371/-	293/-	293/3	297/3	366/9	406/9
White	Muntok faq	–	–	–	291/-	299/9	306/3	375/-	417/6
White	Muntok asta	305/6	331/9	376/9	297/6	298/-	303/6	376/6	417/3
White	Brazil	308/-	337/-	367/6	281/10	312/8	317/6	466/6	469/-
White	Cambodia(4)	570	630	620	560	560	560	730	–
Black	Lampong	–	–	–	203/6	221/-	233/6	356/9	–
Black	Sarawak Special	236/-	285/-	281/6	208/6	226/4	231/6	281/-	360/3
Black	Brazil	225/-	307/-	258/9	206/3	231/6	243/9	368/6	365/3
Black	Madagascar(4)	364,50	419,50	430	351	327	315	500	570
Black	Cambodia(4)	362,50	421	466	414	410	410	500	–

(1) 18.11.67 – Devaluation of sterling by 14.30%
(2) 9. 8.69 – Devaluation of French Franc by 12.50%
(3) 19.12.71 – Devaluation of US Dollar by 7.89%
(4) French Francs per 100 Kg

Source: Table provided by UIPE

An illustration of prices per kilogram of pepper as sold by a grinder in Bordeaux

Prices: Francs per Kg, ex - Value Added Tax

Source and type of pepper	Average import price, duty paid March 1972	When packed in original sack	When packed in 1 kg polythene bags (sifted and cleaned)	When packed in 50 gram tins	When packed in glass jars: 35 grams whole 40 grams ground
Brazil white - whole	8.43	8.60	10.50	19.20	30.00
Brazil white - ground	—	—	11.00	19.60	34.29
Brazil black - whole	6.12	6.30	8.00	17.00	30.00
Brazil black - ground	—	—	8.50	17.40	34.29
Brazil black	5.30	6.60	—	—	—

RETAIL PEPPER PRICES IN FRANCE (VARIOUS BRANDS)

MAY 1972

1. Supermarket - Bordeaux

Plastic Box - 50 gm	francs
Whole white	2.30
Whole black (45 gm)	1.60
Ground white	2.30
Ground black	1.60
Plastic Drums	
125 gm - Whole white	3.25
100 gm - Whole black	2.30
Plastic Pepper Shaker - 15 gm	
Ground white	0.80
Ground black	0.55
Glass Jars - Large	
400 gm - whole black	7.95
500 gm - whole white	12.50
500 gm - mixed broken	9.80
Glass Jars - Small	
45 gm - Ground white	2.20
40 gm - Ground black	2.20

2. Supermarket - Marseilles

Plastic Drums	francs
125 gm - whole black	2.50
50 gm - whole black	1.30
50 gm - ground black	1.30
25 gm - whole black	0.75
25 gm - ground black	0.75
25 gm - whole white	1.00
25 gm - ground white	1.05
Fancy Plastic Pots - 45 gm	francs
whole white	1.50
ground white	1.50
broken white	1.50

3. Bordeaux - Exclusive Epicerie

Loose pepper:	
whole white - per 100 gm	2.50
ground white - per 100 gm	3.00
whole black - per 100 gm	2.00
Green Pepper (Madagascar)	
110 gm - Tin	7.00

CONSUMPTION

As can be seen from Table 19, in the statistical appendix, the observed per capita consumption of pepper increased in France from 46.7 grams per head in 1960 to 89.1 grams per head in 1971. Actual imports more than doubled over the same period, from 2,132 tons to 4,566 tons. During the sixties, apart from the overall growth in population shown in Table 13, three other significant factors were at work which resulted in such a substantial increase. These were:

1. Growth in the acceptance and availability of convenience foods.
2. An important increase in the popularity of more highly spiced and exotic dishes, as illustrated by the increasing number of oriental restaurants in France.
3. An influx of between 3 and 4 million people from ex-French territories, mostly in North Africa, where pepper is very much more widely used than in Europe.

The effect of these special factors is considered largely to have already been felt; thus, although both per capita consumption and total imports are still expected to increase throughout the seventies, as shown by the projections in Table 19, the actual rate of increase is expected to be much slower than in the previous decade.

In so far as possible future developments within the pepper market are concerned, it is likely that increasing use will be made of pepper oleoresins within the industrial sector. At present, only about 20 per cent of the French food industries' pepper consumption is in oleoresin form, compared with about 60 per cent in the United Kingdom. However, there appears to be a greater reluctance on the part of many French food manufacturers to switch from natural forms of pepper to pepper extracts, and so the rate and extent of the change will almost certainly be less marked than in the U.K.

As in Germany, green pepper has also recently appeared on the French market. The most popular brand originates in Malagasy, which is packed in tins of 110 grams each. Total French sales amount to between 100,000 and 200,000 cans per annum (between 10 and 20 tons approx.) No significant upturn in sales is expected, however, mainly because the product is so expensive.

Trade sources consulted in the preparation of the study

The United Kingdom

The General Produce Brokers
Association of London
Plantation House
Mincing Lane
London EC3

British Pepper and Spice Co Ltd
86 Hermitage Wall
London E1

Bryan and Mullinger Ltd
Royal Oak Spice Mills
29 Broomfield Street
London E14

Bush Boake Allen Ltd
100 Carpenters Road
London E15

Campbell's Soups Ltd
King's Lynn
Norfolk

Co-operative Wholesale Society Ltd
Balloon Street
Manchester 4

C Czarnikow Ltd
Plantation House
Mincing Lane
London EC3

Evans, Gray and Hood Ltd
110 Cannon Street
London EC4

H J Heinz Co Ltd
Hayes Park
Hayes
Middlesex

HP Sauce Ltd
Towers Road
Aston Cross
Birmingham 6

E D and F Man (Produce) Ltd
Colonial House
Mincing Lane
London EC3

Marshall, French and Lucas Ltd
29 Mincing Lane
London EC3

McCormick Foods (UK) Ltd
14 Imperial Way
Croydon
Surrey

Gerald McDonald & Co Ltd
1 St Andrews Hill
London EC4

L Noel & Sons Ltd
206 Stewarts Road
London SW8

Paines and Reid
37 Eastcheap
London EC3

Reckitt & Colman Ltd
Food Division
Walkden House
Melton Street
London NW1

Rucker & Bencraft Ltd
5 Fenchurch Street
London EC3

J Sainsbury Ltd
Stamford House
Stamford Street
London SE1

Schwartz Spices Ltd
The Octagon
High Wycombe
Buckinghamshire

Tesco Stores Ltd
Delamere Road
Cheshunt
Hertfordshire

T Wall & Sons (Meat & Handy Foods) Ltd
Walls House
Old Oak Lane
London NW10

Federal Republic of Germany

Waren-Verein der Hamburger Borse eV
Plan 5
2 Hamburg 1

J van den Berge
Adolfstrasse 74
2 Hamburg 76

Cornehls & Bosse
Bei den Muhren 91
2 Hamburg 11

Daarnhouwer & Co
Ost-West Str 49
Hamburg 11

i Fa Carl Dieckmann
Pelzerstr 5
Hamburg 1

Edeka Zentrale GmbH
Basedowstr 2
Hamburg

Gehring & Neiweiser
Sudbrackstr 37a-43
48 Bielefeld

Gewurzmuller
Klagenfurterstr 1-3
7 Stuttgart-Feuerbach

Hagesud GmbH
Wernerstr 19
7 Stuttgart 30

Hamburger Gewurzmuhle
Bargstedgasse 7
2 Hamburg 28

Jantzen & Deeke
Bei den Muhren 70
2 Hamburg 11

Menke & Co
Gr Reichenstr 27
Hamburg 11

Mitsui & Co GmbH
Glockengiesserwall 19
2 Hamburg 1

Norddeutsche Gewurzmuhle
Virchowstr 15
2 Hamburg 50

Ostmann-Gewurze
Markischestr 16
48 Bielefeld

Albert Pantzer
Schauenburgerstr 21
Hamburg 11

Petersen & Paulsen
Kl Reichenstr 21
2 Hamburg 11

Walther Paulsen GmbH
Virchowstr 15
2 Hamburg 50

Ph Seyfried K-G
Lagerstr 11
Postfach 2010
6800 Mannheim 1

Schulze & Co KG
Schweiggerstr 10
85 Nurnberg

Schwag GmbH
Mattentwiete 1
2 Hamburg 11

The Netherlands

Nederlandsche Vereeniging Voor Den Specerijhandel (Netherlands Spice Trade Association)
Westerstraat 29
Rotterdam 2

G Buttner & Co
Henegouwerlaan 43C
Rotterdam

Catz International NV
Blaak 101
PO Box 180
Rotterdam

Daarnhouwer & Co's NV
Herengracht 223-225
Amsterdam-C

Albert Heijn Supermart NV
Ankersmidplein 2
Zaandam

Internatio-Producten NV
Westerstraat 29
Rotterdam

M.P. van Jinnelt
Prins Hendrikkade 152
Amsterdam

Kuijpers van den Boom NV
co Suiker Unie
Weverseinde 343
Puttershoek

Marselis & Liesveld
Berglustlaan 8
Rotterdam 13

E G van Sillevoldt NV
Honigerdijk 49-57
Rotterdam-16

Ten Doesschate NV
PO Box 4
Wapenveld

G de Vries & Zonen NV
Stationsplein 9
Amsterdam

France

Union Interprofesionnelle du Poivre
et des Epices
3 rue de Copenhague
Paris 8e

Syndicat des Importateurs-Triturateurs
de Poivres, Epices et Produits Coloniaux
Alimentaires de Bordeaux
10 rue de la Course
Bordeaux

Syndicat National Francais des
Importateurs-Triturateurs de Poivre,
Epices et Produits Exotiques
Alimentaires
52 avenue Edouard-Vaillant
93-Pantin

Ets G A Aussage
52 avenue Edouard-Vaillant
93-Pantin

S A La Bovida
54 rue du Tir
92-Nanterre

Ets Maurice Daniel
84-88 boulevard de Plombieres
Marseilles

Ets Dubosc
10 rue de la Course
Bordeaux

Ets Ducros et Fils
26-Buis-les-Baronnies
(Drome)

Ets Ingres et Fils
103 Quai de Paludatte
Bordeaux

Krema SA
283 rue de Rosny
Montreuil

Groupe Monoprix
1 rue Paul Cezanne
Paris 8e

Olida SA
10 rue Victor Noir
Neuilly-Sur-Seine

J. Rouanet Fils
17 rue de Louvre
Paris 1er

Jean Saniere
8 rue Haxo
Marseilles

Ste Georges Sicard et Cie
67 cours Pierre-Puget
Marseilles

Varon Freres SA
33 avenue Emile-Counord
Bordeaux

Statistical Appendix

CONTENTS

Statistical commentary

Table 1 United Kingdom: imports of pepper
Table 2 United Kingdom: re-exports of pepper
Table 3 Federal Republic of Germany: imports of pepper
Table 4 The Netherlands: imports of pepper
Table 5 France: imports of pepper
Table 6 Prices: Sarawak white pepper, London spot
Table 7 Prices: Sarawak white pepper, London month-end quotations
Table 8 Prices: Sarawak black pepper, London month-end quotations
Table 9 Prices: Malabar black pepper, London month-end quotations
Table 10 Stocks of pepper in Port of London Authority warehouses
Table 11 Prices of pepper in France, 1969-71
Table 12 Apparent consumption of pepper in selected countries
Table 13 Mid-year population in selected countries with projections to 1980
Table 14 Per capita consumption of pepper in selected countries
Table 15 Per capita consumption of pepper in selected countries adjusted to constant prices
Table 16 United Kingdom: consumption of pepper and projection
Table 17 Federal Republic of Germany: consumption of pepper and projection
Table 18 The Netherlands: consumption of pepper and projection
Table 19 France: consumption of pepper and projection
Table 20 Projected total consumption of pepper in selected countries, 1975 and 1980.

STATISTICAL COMMENTARY

Table 12 shows the apparent annual consumption figures for pepper for the period 1960-71 in the Federal Republic of Germany, the Netherlands, France and the United Kingdom; also an estimate of the price change as compared with that of the previous year. This can only be approximate because of significant changes in the purchasing power of the various currencies during the period 1960-71.

Although it is at once noticeable that apparent consumption is greater towards the end of the period, this may be at least in part, due merely to the natural increase of population.

Table 13 gives the mid-year population for each country in each year of the period 1960-71. It is clear that, in each country separately, since about 1965 the annual movements have been less than in the earlier years. Linear projections have been made, fitting a straight line to the population figures for 1965-1971 only.

Table 14 shows per capita consumption in each year of the period 1960-71, derived from Tables 12 and 13. At least for the first three countries, the apparent upward trend persists quite strongly, although with rather wide fluctuations which appear, at least in part, to be due to changes in price. Corrections for price changes have been derived and are explained below. When applied to the figures they result in the adjusted per capita consumption figures of Table 15.

Although it would be simple to project the linear trend from these figures, it is a matter of experience that upward surges of this nature do not continue indefinitely, but tend to slow down and eventually fluctuate around some limiting value. Taking all four countries together and projecting the linear trend results in an average of 142 grams per capita in 1990 and 173 grams per capita in the year 2000. These were rounded to 140 grams and 175 grams and used for each country as the limiting value.

The method of probit analysis was used to fit the curves to the adjusted figures of Table 15, and to project to the year 1980.

Tables 16 to 19 show the observed per capita and total consumption in each country for the observed period. Also shown are estimates of per capita and total consumption, both for the observed period and for projections up to 1980, assuming that no price changes had occurred. Totals are derived using the mid-year population figures of Table 13. For the United Kingdom, although the trend of per capita consumption is not significant, for the sake of comparability, the estimates have been derived exactly as for the other countries.

For the years 1960-71, the expected figures, according to the fitted curves, can be compared with the adjusted per capita figures of Table 15. The sum of the squares of the residual errors is an indication of the goodness of fit; the smaller the total the better the fit.

Residual sums of square

	Limit 140 grams	*Limit 175 grams*
German Fed Rep	370.41	344.67
Netherlands	340.36	324.29
France	256.66	257.71
United Kingdom	392.31	392.09

None of these differences can be accepted as clearly significant, but for the German Federal Republic and the Netherlands the limit of 175 grams does make a substantial reduction. For France and the United Kingdom the differences are quite trivial.

Table 20 gives a summary of the estimates, together with the changes to be expected in response to price fluctuations, for 1975 and 1980.

Corrections for price changes

Projections are based on the assumption that there is a tendency for per capita consumption to increase by the same amount each year, and that this tendency may then be affected by changes in price.

For each country a regression equation has been calculated, of the form

$$Y = a + b_1 \, x_1 + b_2 \, x_2$$

Where y is the estimate of per capita consumption in grams
x_1 is the number of the year, starting with 1960 = 1
x_2 is the percentage change in price of imports since the previous year
and a_1 b_1 and b_2 are constants to be estimated from the data.

Example For the Federal Republic of Germany the figures are:–

Year	x_1	x_2	y	*Correction*	*Corrected* y
1960	1	+85.7	55.5	+13.0	68.5
1961	2	–17.5	75.6	– 2.6	73.0
1962	3	–21.2	81.3	– 3.2	78.1
1963	4	–13.4	78.8	– 2.0	76.8
1964	5	– 4.8	73.5	– 0.7	72.8
1965	6	+19.2	93.8	+ 2.9	96.7
1966	7	+12.1	83.4	+ 1.8	85.2
1967	8	–22.2	104.5	– 3.4	101.1
1968	9	– 9.4	102.8	– 1.4	101.5
1969	10	+ 9.6	106.2	+ 1.5	107.7
1970	11	+27.5	100.2	+ 4.2	104.4
1971	12	– 0.8	118.6	– 0.1	118.5

and the normal equations

$$646.45 = 143 \, b_1 - 1.851 \, b_2$$
$$-22.9707 = 1.851 \, b_1 + 0.989816 \, b_2$$

which yield the estimating equation

$$y = 62.00 + 4.36x_1 - 0.1512x_2$$

The figure –0.1512 is then used to correct the per capita figures to those which would have been expected if there had been no change in price. Thus for 1960 the discrepancy due to price change is

$$-0.1512 \times 85.7 = -13.0$$

and to correct this 13.0 is added to the observed figure. Similar corrections are made in each year, and the result is a series from which fluctuations due to price changes have largely been eliminated.

This was repeated for each country in turn, giving the estimating equations:–

Netherlands	$y = 32.17 + 3.73x_1 \; -0.1255x_2$
France	$y = 49.76 + 3.09x_1 \; -0.1031x_2$
United Kingdom	$y = 63.15 - 0.59x_1 \; -0.1126x_2$

Projections

It is assumed that in each country there will be a period of slow growth followed by a period of more rapid growth caused by some stimulus, and again a period of slower growth towards the limit.

Two separate limits are used; 140 grams, which would approximate to the 1990 level for the four countries combined if the linear trend in the period 1960-71 continued unabated, and 175 grams, which would approximate to that in the year 2000 under those conditions.

The model is a sigmoid or cumulative normal curve fitted by probit analysis, using Table 6 of the Biometrica Tables for Statisticians. For an assumed limit of 140 grams the estimating equations are:—

German Fed Rep	Probit $y = 4.8333 + 0.0856x$
Netherlands	Probit $y = 4.2919 + 0.0700x$
France	Probit $y = 4.6343 + 0.0558x$
United Kingdom	Probit $y = 4.8770 - 0.0107x$

and for an assumed limit of 175 grams they are:—

German Fed Rep	Probit $y = 4.6325 + 0.0630x$
Netherlands	Probit $y = 4.1368 + 0.0603x$
France	Probit $y = 4.4466 + 0.0453x$
United Kingdom	Probit $y = 4.6443 - 0.0092x$

It is interesting to compare the 1980 projected per capita figures using the two limits:—

	Limit 140 gr	*Limit 175 gr*	*Change in estimate*
German Fed Rep	132.8	145.3	+12.5
Netherlands	108.8	114.9	+ 6.1
France	110.6	114.6	+ 4.0
United Kingdom	50.96	51.02	+ 0.06
Weighted mean	99.9	105.7	+ 5.8

Raising the limit by 35 gr results in an average estimated increase of less than 6 gr. If the limit were further increased, say by another 35 gr, the resulting estimates for 1980 would be only slightly increased, probably by about 3 grams on the average.

Table 1

United Kingdom - imports of pepper

Quantity: metric tons
Value: £ thousands

Countries of Origin		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970 (1)	1971
Singapore	Q	2,112	1,415	1,315	1,769			540	998	1,548	1,908	1,697	
	V	1,286	587	436	523			215	303	455	634	. . .	
Malaysia	Q					2,213	1,873	1,248	1,200	802	505	1,036	
	V					659	661	523	394	246	182	. . .	
Sarawak	Q	881	1,320	1,186	1,719								
	V	573	535	394	532								
British North Borneo	Q				102								
	V				31								
Brazil	Q	406	517	381	265	228	278	381	495	389	661	188	
	V	207	218	120	75	63	89	136	150	112	201	. . .	
Indonesia	Q	23	68	63	51	772	449	292	601	151	219	41	
	V	14	28	21	16	171	141	101	141	40	72	. . .	
India	Q				92	43				(20)	(15)	10	
	V				20	12							
Netherlands	Q						63	275					
	V						22	84					
Surinam	Q				50	66							
	V				15	18							
Ceylon	Q									(36)	(157)	10	
	V											. . .	
Others	Q	260	152	195	50	16	46	115	139	98	269	152	
	V	118	44	53	15	4	16	41	37	25	77	. . .	
TOTAL	Q	3,682	3,472	3,140	4,098	3,338	2,709	2,851	3,433	2,988	3,562	3,134	2,885
	V	2,198	1,412	1,024	1,227	927	929	1,100	1,025	878	1,166	1,305	1,196

(1) These and the bracketed figures from *Tropical Products Quarterly*

Source: *Provided by FAO*

. . . Not available

Table 2

United Kingdom - re-exports of pepper

Quantity: metric tons
Value: £ thousands

Countries of Destination		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Irish Republic	Q	45	39	44	...	...	...	...	...	...	...	
	V	27	16	15	...	...	...	...	...	...	...	
Commonwealth countries	Q	818	17	5	...	...	...	...	...	...	...	
	V	537	7	2	...	...	...	...	...	...	...	
TOTAL ABOVE	Q	863	56	49	33	24	18	19	10	18	14	
	V	564	23	17	11	7	7	7	3	6	4	
Poland	Q	–	3	20	...	...	...	...	...	...	...	
	V	–	1	7	...	...	...	...	...	...	...	
Federal Republic of Germany	Q	29	3	21	...	...	...	...	...	...	...	
	V	12	1	9	...	...	...	...	...	...	...	
Italy	Q	5	1	9	...	...	...	...	...	...	...	
	V	3	1	4	...	...	...	...	...	...	...	
Other foreign countries	Q	44	22	27	...	...	...	...	...	...	...	
	V	23	10	9	...	...	...	...	...	...	...	
TOTAL FOREIGN COUNTRIES	Q	78	29	77	14	23	48	17	4	13	65	
	V	38	13	29	5	7	19	7	2	4	15	
TOTAL	Q	941	85	126	47	47	66	36	14	31	79	
	V	602	36	46	16	14	26	14	5	10	19	

Source: *Provided by FAO*
. . . Not available
– Nil or negligible

Table 3

Federal Republic of Germany - imports of pepper

Quantity: metric tons
Value: DM thousands

Countries of Origin		1960	1961	1962	1963	1964	1965 (2)	1966	1967	1968	1969	1970	1971
Cameroon	Q							23		29	36	36	
	V							83		69	88	98	
Malagasy	Q	5				38	259	77	5	83	38	39	
	V	31				112	...	307	18	245	107	179	
Brazil	Q	496	328	430	532	637	1,006	811	1,142	893	1,534	611	
	V	2,396	1,603	1,545	1,675	1,892	...	3,270	3,702	2,452	4,344	2,086	
India	Q	82	64	163	14	19	81	40	36	32	34	123	
	V	322	235	486	36	46	...	153	119	83	56	422	
Ceylon	Q	4	4							41	56	12	
	V	22	19							86	119	31	
Indonesia	Q	572	524	644	852	2,192	1,951	2,431	2,653	1,726	1,667	819	
	V	2,434	1,937	2,113	2,481	6,520	...	9,581	8,072	4,674	4,855	2,245	
Malaysia (1)	Q	64	53	10	7	1,223	1,961	1,405	2,166	3,002	2,663	4,031	
	V	285	262	33	21	4,038	...	6,095	7,570	3,599	7,766	1,389	
Singapore	Q	51	172	138	156					149	190	278	
	V	276	731	469	472					413	587	942	
EEC	Q		2	—	1	—		—	1	2	11	1	
	V		43	5	14	8		6	11	16	78	3	
Brunei	Q	1,676	2,936	3,063	2,792								
	V	10,204	14,043	11,078	9,009								
USA	Q	2	2	3	12	8		5	7	2	2		
	V	27	28	40	79	71		53	41	26	25		
Austria	Q					7		3	9	6			
	V					41		21	51	34			
Others	Q	2	2	1	4	1	76	1	4	7	5	5	5
	V	16	5	9	17	2	...	6	15	18	9	38	
TOTAL	Q	2,956	4,087	4,452	4,370	4,125	5,334	4,796	6,028	5,972	6,236	5,954	7,137
	V	16,013	18,906	15,778	13,804	12,730	...	19,575	19,599	16,720	18,034	20,436	...

(1) 1960 to 1963 includes Malaya

(2) Source: *Tropical Products Quarterly*

Source: *Provided by FAO*

. . . Not available

—Nil or negligible

Table 4

The Netherlands - imports of pepper

Quantity: metric tons
Value: thousand Guilders

Countries of Origin		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Belgium/Luxemburg	Q	18	3	12	10	2	34	6	2	–	1	13	
	V	90	12	41	31	7	125	28	18	1	11	45	
Federal Republic of Germany	Q	21	8		13	14	48	19	5	8	17	69	
	V	116	31		39	41	172	60	18	24	53	273	
United Kingdom	Q	2		10		19	5	5			5	5	
	V	15		33		46	22	26			14	13	
Brazil	Q	39	39	14	43		14	23	116	54	102	46	
	V	164	178	20	139		46	102	365	145	251	174	
Ceylon	Q										5	9	
	V										11	32	
Singapore	Q	169	392	343	379			84	158	157	189	290	
	V	868	1,630	1,124	1,118			342	481	412	526	1,019	
Indonesia	Q	13	70	74	139	305	343	519	628	480	573	403	
	V	70	277	256	425	913	1,142	2,065	1,935	1,262	1,591	1,483	
Malaysia	Q		2		5	149	153	37	9	10	53	85	
	V		11		16	455	534	149	31	26	148	299	
British Borneo	Q	22	3	31	44								
	V	116	14	103	134								
Surinam	Q					55							
	V					150							
USA	Q	1	4	4	1								
	V	11	16	20	17								
India	Q	6					12	23					
	V	10					11	55					
Others	Q	1	5	8	7	2	6	2	–	8	19	4	
	V	8	–	54	14	16	20	10	1	26	25	15	
TOTAL	Q	292	526	496	641	546	615	718	918	717	964	924	989
	V	1,468	2,168	1,651	1,933	1,628	2,072	2,837	2,849	1,896	2,623	3,353	. . .

Source: *Provided by FAO*
. . . Not available
—Nil or negligible

Table 5

France - imports of pepper

Quantity: metric tons
Value: thousand francs

Countries of Origin		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Malagasy	Q	707	938	887	671	1,096	579	948	842	1,302	1,903	640	
	V	4,999	7,032	5,968	3,239	4,303	2,818	4,600	3,245	4,610	7,541	3,555	
Ecuador	Q											17	
	V											97	
Brazil	Q		11	31	249	607	375	380	1,339	1,081	1,474	713	
	V		61	143	1,050	2,337	1,888	2,009	5,239	3,819	6,750	4,339	
Ceylon	Q									30	33	22	
	V									72	95	120	
North Vietnam	Q										32	32	
	V										189	137	
Cambodia	Q	1,139	793	903	582	732	1,418	1,024	170	352	56	475	
	V	9,513	6,980	6,460	2,905	2,868	6,719	5,425	767	1,516	265	2,726	
Indonesia	Q	28	219	336	464	493	348	524	979	634	375	379	
	V	149	1,130	1,595	2,033	2,021	1,830	2,750	3,470	2,132	1,638	2,207	
Malaysia	Q	21	84	226	201	208	116	513	223	382	256	1,327	
	V	157	448	965	773	815	674	2,497	928	1,211	1,141	6,636	
Singapore	Q	17	13							192	151	159	
	V	124	76							585	657	847	
China	Q											11	
	V											67	
Cameroon	Q				29	53	37		63				
	V				117	198	167		237				
India	Q			213	184	35		61	41				
	V			819	617	72		210	140				
British Borneo	Q	209	296	648	558								
	V	1,595	1,649	2,664	1,821								
Others	Q	11	14	16	18	25	31	33	9	49	40	32	
	V	68	73	84	96	98	154	184	63	240	161	183	
TOTAL	Q	2,132	2,368	3,260	2,956	3,249	2,904	3,483	3,666	4,022	4,320	3,807	4,566
	V	16,605	17,449	18,698	12,651	12,712	14,250	17,675	14,089	14,185	18,437	20,914	. . .

Source: *Provided by FAO*

. . . Not available

Table 6
Pepper prices
London Spot - Sarawak White

(new pence per kg)

	1965	1966	1967	1968	1969	1970	1971
January	35.83	47.77	33.99	34.45	29.87	54.56	42.57
February	31.12	43.17	31.69	32.97	29.03	52.36	41.70
March	33.07	41.34	34.94	31.99	30.02	48.00	42.69
April	31.92	43.17	32.12	30.76	25.59	39.15	42.82
May	32.15	38.35	32.97	29.28	31.00	41.34	43.67
June	33.76	37.89	32.72	28.79	31.74	45.22	45.03
July	39.04	41.34	30.51	29.53	34.94	49.94	48.23
August	39.04	42.03.	29.33	28.30	36.91	48.96	48.23
September	42.03	37.43	29.03	29.53	47.31	48.23	48.23
October	51.44	37.20	29.77	31.99	62.69	45.87	52.81
November	46.39	37.43	31.74	33.07	58.24	45.27	58.72
December	47.77	37.43	32.72	32.58	46.96	44.29	57.08
Average	38.64	40.38	31.80	31.10	38.69	46.93	47.65

Month-end quotations (from *Tropical Products Quarterly)* up to August 1969
Monthly averages (from Public Ledger) since September 1969
Source: *Table provided by FAO*

Table 7
Pepper prices
London month-end quotations - Sarawak White Pepper

(new pence per kg)

	1965	1966	1967	1968	1969	1970	1971
January	35.83	47.77	33.99	34.45	29.87	41.34	39.12
February	31.23	43.17	31.69	32.97	29.03	42.32	41.58
March	33.07	41.34	34.94	31.99	30.02	37.89	41.34
April	31.92	43.17	32.18	30.76	25.59	36.66	40.60
May	32.15	38.35	32.97	29.28	31.00	38.63	41.83
June	33.76	37.89	32.72	28.79	31.74	48.72	42.81
July	39.04	41.34	30.51	29.53	34.94	45.76	45.76
August	39.04	42.03	29.33	28.30	36.91	45.76	45.76
September	42.03	37.43	29.03	29.53	62.99	44.04	46.26
October	51.44	37.20	29.77	31.99	63.38	42.32	53.15
November	46.39	37.43	31.74	33.07	48.22	48.81	53.64
December	47.77	37.43	32.72	32.58	55.11	42.07	
Average	38.64	40.38	31.80	31.10	39.90	42.36	44.71 (1)

(1) Average of 11 months
Source: *Tropical Products Quarterly (Table provided by FAO)*

Table 8
Pepper prices
London month-end quotations - Sarawak Black Pepper

(new pence per kg)

	1965	1966	1967	1968	1969	1970	1971
January	35.83	34.91	26.64	29.03	23.87	31.00	36.41
February	30.77	33.07	24.11	27.56	23.13	31.00	39.37
March	30.77	31.92	24.31	26.82	24.36	29.53	38.38
April	27.56	31.92	25.29	24.11	25.59	28.05	34.45
May	28.25	28.48	23.88	23.37	24.11	29.53	35.43
June	28.25	28.94	22.96	23.13	23.62	39.37	35.43
July	31.69	31.23	21.82	22.39	25.34	38.38	36.17
August	31.69	30.77	19.93	22.88	27.06	39.37	36.66
September	33.53	28.94	20.67	23.37	43.30	37.89	35.92
October	34.91	28.48	24.60	24.85	40.35	38.87	36.91
November	33.07	27.56	26.57	25.10	35.43	38.14	36.91
December	33.07	27.10	28.54	24.36	36.91	37.40	
Average	31.62	30.28	24.11	24.75	29.42	34.88	36.55 (1)

(1) Average of 11 months

Source: *Tropical Products Quarterly (Table provided by FAO)*

Table 9
Pepper prices
London month-end quotations - Malabar Black Pepper

(new pence per kg)

	1965	1966	1967	1968	1969	1970	1971
January	36.41	36.91	26.82	33.46	32.97	48.96	50.19
February	33.46	34.45	27.31	32.72	32.48	52.65	52.65
March	36.41	33.95	28.05	36.66	32.48	52.16	55.11
April	34.93	34.45	29.03	31.49	35.43	45.27	55.11
May	35.43	33.95	29.03	32.48	34.94	47.73	54.13
June	36.91	31.74	30.02	32.97	35.43	59.05	54.62
July	40.35	33.46	29.53	32.97	34.94	58.56	54.62
August	38.38	33.22	28.05	34.45	37.89	59.05	54.13
September	37.40	30.51	28.05	34.69	63.97	55.11	51.67
October	36.41	31.00	29.53	33.95	54.13	52.65	—
November	34.93	29.52	32.48	33.71	51.18	50.19	48.22
December	34.45	29.77	31.99	33.46	52.65	42.21	
Average	36.29	32.74	29.16	33.58	41.54	51.97	53.04 (1)

(1) Average of 10 months

Source: *Tropical Products Quarterly (Table provided by FAO)*

Table 10

Stocks of pepper in Port of London Authority Warehouses (1)

Quantity: metric tons

	1965			1966			1967			1968			1969			1970			1971		
	Black	White	Total	Black	White	Total	Black	White	Total	Black	White	Total	Black	White	Total	Black	White	Total	Black	White	Total
January	151	440	591	181	71	252	118	87	205	17	96	113	9	312	321	46	80	126	5	69	74
February	176	397	573	118	82	200	140	204	344	63	103	166	90	259	349	57	68	125	5	59	64
March	89	398	487	69	146	215	135	185	320	62	242	304	95	237	332	57	53	110	5	74	79
April	65	389	454	46	122	168	123	154	277	38	328	366	92	187	279	42	129	171	–	71	71
May	51	366	417	49	81	130	75	94	169	31	318	349	78	151	229	29	144	173	–	71	71
June	52	372	424	47	87	134	75	87	162	17	303	320	63	86	149	22	81	103	–	46	46
July	35	258	293	34	134	168	99	143	242	17	273	290	63	62	125	14	66	80	–	25	25
August	13	290	303	37	153	190	59	192	251	14	246	260	61	120	181	4	90	94	5	25	30
September	15	264	279	31	163	194	66	171	237	45	264	309	48	94	142	3	80	83	5	25	30
October	7	227	234	146	164	309	46	108	154	31	228	259	3	82	85	49	80	129	–	25	25
November	203	142	345	133	162	295	35	122	157	14	218	232	46	117	163	41	80	121	–	25	25
December	173	112	285	119	108	227	83	138	221	13	248	261	129	100	229	41	76	117	–	25	25

(1) Stocks held on last day of month

Source: *The General Produce Brokers' Association of London (Table provided by FAO)*

– Nil or negligible

Table 11

France - Poivre

Prix Ponderes du Poivre an 1969 - 1970 - 1971 (Francs/Metric ton Caf)

		Poivre noir			Poivre blanc		
Month—end		Madagascar	Brésil *	Sarawak *	Brésil *	Muntok *	Sarawak *
1969	31/1	3300	3267	2987	4511	4440	4258
	28/2	3297	3286	2974	4356	4164	4074
	31/3	3290	3396	—	4372	4092	4210
	30/4	3220	—	—	4212	—	4310
	31/5	3265	—	—	4150	4210	—
	30/6	3397	—	3010	4180	4280	4130
	31/7	3400	—	3170	4499	4267	4409
	31/8	3550	—	—	4835	4835	—
	30/9	4513	4209	—	5647	5687	—
	31/10	6463	6577	6137	8504	—	8597
	30/11	6164	5979	5878	7872	7935	7960
	31/12	5209	—	4929	7747	6453	6722
1970	31/1	5132	6004	4963	7641	6654	7065
	28/2	5197	5149	4622	7526	6378	6289
	31/3	5037	5332	4586	7276	6319	6416
	30/4	5003	5514	4248	—	5453	5577
	31/5	5001	5500	4430	6542	5981	5649
	30/6	5140	5453	4776	6709	5631	5923
	31/7	5401	6280	5440	7474	7452	7070
	30/8	5625	—	5643	6823	7154	6945
	30/9	—	6287	5548	7296	6967	6770
	31/10	5984	6021	5516	7292	6918	6708
	30/11	6079	5930	5603	7494	6466	6523
	31/12	5822	5804	5501	7107	6645	6386
1971	31/1	5843	5293	5286	6785	6295	5896
	28/2	5884	5423	5328	6725	6266	5960
	31/3	5971	5689	5470	6661	6141	6136
	30/4	5947	5961	5293	7041	6250	6098
	31/5	6025	6025	5373	—	6326	6128
	30/6	5974	5836	5284	7127	6588	6422
	31/7	5946	5623	5214	—	6628	6650
	30/8	—	5535	5261	7176	6981	6668
	30/9	5551	5424	—	7313	6716	6834
	31/10	5445	5354	5290	8014	7199	6981
	30/11	5652	5463	5270	8173	8656	7972
	31/12	5736	5537	5180	8755	7769	—

* Droits de Douane compris

Source: *Table provided by FAO*

—Nil or negligible

Table 12

Apparent consumption of pepper in selected countries

Metric tons

Year	German Federal Republic	Netherlands	France	United Kingdom	Price Change
				(a)	(b)
1960	2,954	292	2,132	2,741	+ 85.7
1961	4,087	526	2,368	3,387	−17.5
1962	4,452	496	3,260	3,014	−21.2
1963	4,370	641	2,956	4,051	−13.4
1964	4,125	546	3,249	3,291	− 4.8
1965	5,334	615	2,904	2,949	+ 19.2
1966	4,796	718	3,483	2,873	+ 12.1
1967	6,028	918	3,666	3,425	−22.2
1968	5,972	717	4,022	2,917	− 9.4
1969	6,236	964	4,320	3,515	+ 9.6
1970	5,954	924	3,807	3,185	+ 27.5
1971	7,137	989	4,566	2,936	− 0.8

(a) Figures of imports less re-exports, and from 1965 to 1971, adjusted for changes in stocks at 31 December of each year

(b) Percentage change, compared with the previous year, in the average price of imports, taking all four countries together.

Sources:- *Official trade statistics of each country*, and *The General Produce Brokers Association of London.*

Table 13

Mid-year population in selected countries
With projections to 1980

Thousands

Year	German Federal Republic	Netherlands	France	United Kingdom
1960	53224	11480	45684	52352
1961	54029	11637	46163	52816
1962	54767	11797	46998	53341
1963	55430	11967	47816	53678
1964	56097	12127	48310	54066
1965	56839	12292	48758	54436
1966	57485	12455	49164	54744
1967	57699	12597	49548	55068
1968	58015	12725	49914	55283
1969	58707	12873	50320	55534
1970	59430	13030	50780	55730
1971	60180	13190	51260	55950

Source: *Demographic Yearbook and Monthly Bulletin of Statistics United Nations*

Linear projections, using a straight line fitted to the 1965 to 1971 inclusive figures:-

Year	German Federal Republic	Netherlands	France	United Kingdom
1972	60468	13309	51555	56217
1973	61001	13452	51953	56459
1974	61534	13595	52351	56701
1975	62067	13738	52749	56943
1976	62600	13881	53147	57185
1977	63133	14024	53545	57427
1978	63666	14167	53943	57669
1979	64199	14310	54341	57911
1980	64732	14453	54739	58153

Table 14

Per capita consumption of pepper in selected countries

grams

Year	German Federal Republic	Netherlands	France	United Kingdom
1960	55.5	25.4	46.7	52.4
1961	75.6	45.2	51.3	64.1
1962	81.3	42.0	69.4	56.5
1963	78.8	53.6	61.8	75.9
1964	73.5	45.0	67.3	60.9
1965	93.8	50.0	59.6	54.2
1966	83.4	57.6	70.8	52.5
1967	104.5	72.9	74.0	62.2
1968	102.9	56.3	80.6	52.8
1969	106.2	74.9	85.9	63.3
1970	100.2	70.9	75.0	57.2
1971	118.6	75.0	89.1	52.5

Source: Tables 12 and 13

Table 15

Per capita consumption of pepper in selected countries adjusted to constant prices

grams

Year	German Federal Republic	Netherlands	France	United Kingdom
1960	68.5	36.2	55.5	62.0
1961	73.0	43.0	49.5	62.1
1962	78.1	39.3	67.2	54.1
1963	76.8	51.9	60.4	74.4
1964	72.8	44.4	66.8	60.4
1965	96.7	52.4	61.6	56.4
1966	85.2	59.1	72.0	53.9
1967	101.1	70.1	71.7	59.7
1968	101.5	55.1	79.6	51.7
1969	107.7	76.1	86.9	64.4
1970	104.4	74.4	77.8	60.3
1971	118.5	74.9	89.0	52.4

Source: Data of Table 14 corrected
(see Statistical Commentary)

Table 16
United Kingdom
Consumption of pepper and projection

Year	Observed	Fitted Curves		Observed	Fitted Curves	
		Low Limit	High Limit		Low Limit	High Limit
	Per capita figures in grams			*Total figures in metric tons*		
1960	52.4	62.5	62.6	2741	3275	3276
1961	64.1	62.0	62.0	3387	3272	3274
1962	56.5	61.4	61.4	3014	3274	3274
1963	75.9	60.8	60.8	4051	3263	3263
1964	60.9	60.2	60.2	3291	3254	3254
1965	54.2	59.6	59.6	2949	3245	3244
1966	52.5	59.0	59.0	2873	3231	3230
1967	62.2	58.4	58.4	3425	3218	3217
1968	52.8	57.8	57.8	2917	3198	3198
1969	63.3	57.3	57.3	3515	3180	3180
1970	57.2	56.7	56.7	3185	3159	3159
1971	52.5	56.1	56.1	2936	3139	3139
Projection:						
1972	–	55.5	55.5	–	3122	3122
1973	–	54.9	54.9	–	3102	3102
1974	–	54.4	54.4	–	3083	3083
1975	–	53.8	53.8	–	3064	3065
1976	–	53.2	53.3	–	3044	3045
1977	–	52.7	52.7	–	3024	3026
1978	–	52.1	52.1	–	3004	3006
1979	–	51.5	51.6	–	2984	2986
1980	–	51.0	51.0	–	2963	2967

Table 17
Federal Republic of Germany
Consumption of pepper and projection

Year	Observed	Fitted Curves		Observed	Fitted Curves	
		Low Limit	High Limit		Low Limit	High Limit
	Per capita figures in grams			*Total figures in metric tons*		
1960	55.5	65.5	66.6	2954	3485	3543
1961	75.6	70.2	70.8	4087	3796	3825
1962	81.3	75.0	75.1	4452	4109	4113
1963	78.8	79.8	79.4	4370	4421	4404
1964	73.5	84.4	83.8	4125	4736	4703
1965	93.8	89.0	88.2	5334	5058	5015
1966	83.4	93.4	92.6	4796	5370	5325
1967	104.5	97.7	97.0	6028	5637	5597
1968	102.9	101.8	101.3	5972	5905	5879
1969	106.2	105.7	105.6	6236	6203	6201
1970	100.2	109.3	109.8	5954	6496	6527
1971	118.6	112.7	114.0	7137	6784	6858
Projection:						
1972	–	115.9	118.0	–	7009	7134
1973	–	118.8	121.9	–	7249	7436
1974	–	121.5	125.7	–	7478	7734
1975	–	124.0	129.3	–	7694	8028
1976	–	126.2	132.8	–	7898	8316
1977	–	128.1	136.2	–	8090	8599
1978	–	129.9	139.4	–	8270	8875
1979	–	131.4	142.4	–	8438	9145
1980	–	132.8	145.3	–	8596	9406

Table 18
The Netherlands
Consumption of pepper and projection

Year	Observed	Fitted Curves		Observed	Fitted Curves	
		Low Limit	High Limit		Low Limit	High Limit
	Per capita figures in grams			*Total figures in metric tons*		
1960	25.4	36.6	36.9	292	420	424
1961	45.2	39.9	40.0	526	464	465
1962	42.0	43.3	43.3	496	511	511
1963	53.6	46.8	46.7	641	560	559
1964	45.0	50.4	50.2	546	611	609
1965	50.0	54.1	53.9	615	665	663
1966	57.6	57.9	57.7	718	721	709
1967	72.9	61.8	61.5	918	778	775
1968	56.3	65.6	65.5	717	835	833
1969	74.9	69.6	69.5	964	896	895
1970	70.9	73.5	73.6	924	958	959
1971	75.0	77.4	77.8	989	1021	1026
Projection:						
1972	–	81.2	82.0	–	1081	1091
1973	–	85.0	86.2	–	1143	1159
1974	–	88.7	90.4	–	1206	1229
1975	–	92.4	94.6	–	1269	1300
1976	–	95.9	98.8	–	1331	1371
1977	–	99.3	102.9	–	1393	1443
1978	–	102.6	107.0	–	1454	1516
1979	–	105.8	111.0	–	1514	1588
1980	–	108.8	114.9	–	1572	1661

Table 19
France
Consumption of pepper and projection

Year	Observed	Fitted Curves		Observed	Fitted Curves	
		Low Limit	High Limit		Low Limit	High Limit
	Per capita figures in grams			*Total figures in metric tons*		
1960	46.7	53.0	53.5	2132	2419	2444
1961	51.3	56.0	56.3	2368	2583	2599
1962	69.4	59.0	59.2	3260	2773	2781
1963	61.8	62.1	62.1	2956	2968	2969
1964	67.3	65.2	65.1	3249	3148	3144
1965	59.6	68.3	68.1	2904	3329	3320
1966	70.8	71.4	71.2	3483	3510	3499
1967	74.0	74.5	74.3	3666	3691	3679
1968	80.6	77.6	77.4	4022	3873	3861
1969	85.9	80.7	80.5	4320	4059	4051
1970	75.0	83.7	83.7	3807	4251	4248
1971	89.1	86.7	86.8	4566	4445	4450
Projection:						
1972	–	89.7	90.0	–	4622	4639
1973	–	92.6	93.1	–	4809	4838
1974	–	95.4	96.3	–	4993	5040
1975	–	98.1	99.4	–	5176	5244
1976	–	100.8	102.5	–	5357	5448
1977	–	103.4	105.6	–	5536	5653
1978	–	105.9	108.6	–	5711	5859
1979	–	108.3	111.6	–	5884	6066
1980	–	110.6	114.6	–	6054	6271

Table 20

Projected total consumption of pepper in selected countries for 1975 and 1980

Metric tons

	German Fed Rep	Netherlands	France	United Kingdom	Total
1975					
(a) *Per capita limit 140 grams*					
(1) Average price 10% above 1974	7,600	1,252	5,122	3,026	17,000
(2) No change in price	7,694	1,269	5,176	3,064	17,203
(3) Average price 10% below 1974	7,788	1,286	5,230	3,102	17,406
(b) *Per capita limit 175 grams*					
(1) Average price 10% above 1974	7,934	1,283	5,190	3,027	17,434
(2) No change in price	8,028	1,300	5,244	3,065	17,637
(3) Average price 10% below 1974	8,122	1,317	5,298	3,103	17,840
1980					
(a) *Per capita limit 140 grams*					
(1) Average price 10% above 1979	8,498	1,554	5,998	2,926	18,976
(2) No change in price	8,596	1,572	6,054	2,963	19,185
(3) Average price 10% below 1979	8,694	1,590	6,110	3,000	19,394
(b) *Per capita limit 175 grams*					
(1) Average price 10% above 1979	9,308	1,643	6,215	2,930	20,096
(2) No change in price	9,406	1,661	6,271	2,967	20,305
(3) Average price 10% below 1979	9,504	1,679	6,327	3,004	20,514

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Patricia L. Day

mber 1973

Tropical Products Institute 56/62 Gray's Inn Road London WC1X 8LU
Foreign and Commonwealth Office (Overseas Development Administration)

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The Director
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU

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Contents

Acknowledgements and introductory note

SUMMARIES — Page

Summary 1

Sommaire 2

Resumen 3

CHAPTER 1: THE PURPOSE AND SCOPE OF THE REPORT

Introduction 6

Choice of process: extrusion 6

The products of extrusion 7

Outline of the report 7

Costings: a preliminary caution 8

CHAPTER 2: OUTLINE OF PROCESS AND PRODUCTS

Extrusion 9

The extruder 10

Raw materials 15

Pipe and tube 15

Film and sheet 16

Additional equipment and facilities 17

Plastics degradation and waste disposal 18

CHAPTER 3: DESIGN OF MODELS

Economies of scale 20

Description of models 21

The models 22

CHAPTER 4: INTERPRETATION OF COST MODELS

Purpose of cost models 24

Rate of return 24

Capital recovery period 25

Observations 25

Conclusion 26

TABLES

Table 1 : Capital and annual operating costs 27
Table 2 : Effects of taxation and allowances 28
Table 3a : Initial allowances (first year of production only) 29
Table 3b : Annual allowances 29
Table 4 : Physical requirements 30
Table 5 : Transport requirements and costs for distribution of product 31
Table 6 : Quantities and costs of raw material input and product output 32
Table 7 : Water requirements and costs 33
Table 8 : Labour requirements 34

APPENDIX 1: LISTS OF MACHINERY FOR EACH MODEL 35

APPENDIX 2: SOURCES OF FURTHER INFORMATION 37

APPENDIX 3: CONVERSION FACTORS 39

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Information on suppliers of machinery, equipment and other requirements of the plastics industry may be found in the *British Plastics Year Book* published every twelve months by Engineering, Chemical and Marine Press Ltd., 33–40 Bowling Green Lane, London EC1. This book contains fairly comprehensive information on the plastics industry and also contains the names and addresses of firms and manufacturers overseas, listed country by country.

A list of reference books and other sources of information is provided in the appendix.

Summaries

SUMMARY

The extrusion of plastics film, sheet and pipe

This report is one of a series of economic studies designed to provide guidance for investment decisions in developing countries. Little has been written about the plastics industry in the context of the developing countries, particularly about the economics of equipping and operating a processing plant. This report is concerned with the production of extruded plastics using low density polyethylene, known as polythene, for the manufacture of flexible film, sheet and pipe and using polyvinylchloride, known as PVC, for the manufacture of rigid pipe.

The demand for extruded plastics, particularly for their agricultural applications, is expected to increase rapidly in developing countries. Film and sheet have a variety of uses apart from packaging, such as soil covering, plant protection, irrigation channel lining and crop storage. Plastics pipe in flexible or rigid form can be used for water supply, drainage purposes and irrigation. It is probable that the successful development of trickle irrigation systems would be encouraged in many developing countries if plastics pipe could be made more easily available through local production.

Extrusion is a continuous process whereby plastics material is fed continuously into a machine where it is compressed, causing it to become heated and thus plasticised and from which it is expressed through a die head which imparts the desired profile to the plastics material. This firm plastics profile must then be delivered to the cooling area for solidification without distortion to its shape. It is then cut, reeled or coiled according to the particular product. The price of an extruder depends upon the degree of flexibility and automation of operation provided. Extrusion can be an intermediate process before various moulding or shaping processes take place and the investment cost of the post-extrusion equipment is often greater than the cost of the extruder.

Of the several types of extruder available, it appears that the single screw type is more popular than the twin screw type and single screw machines can extrude virtually the complete range of theremoplastic materials at the lowest investment cost per pound. Length of run is critical in determining the size of the extruder: for long runs a high output single screw extruder together with automated sizing and takeoff equipment is recommended. If there are frequent change-overs in product a high proportion of scrap will be generated from one large machine and the use of several small extruders would be more economical.

Four of the cost models presented in the report are based on the output of a single extruder, either 60 mm or 90 mm in diameter, producing blown film, sheet or pipe. Two further models demonstrate the effect on production costs of adding a second extruder to the blown film and pipe lines. Doubling the output does not proportionally increase the personnel since one worker can supervise

several automatic extruders and the minimum total work force for all models remains at about ten persons including three technically skilled supervisors. Outputs range from 500 to 1 200 metric tons per year, a 24 hour shift system being worked for 300 days in the year. A factory floorspace of 200 m² is adequate for two blown film or pipe extrusion lines, and 350 m² for sheet extrusion. The blown film line requires a building from 6 to 8 m high to accommodate the cooling tower. The total capital investments for the six models range from £40 000 to £120 000 including investments in land, buildings, plant, vehicles and working capital for three months' operating costs which range from £18 000 to £47 000.

Since raw material costs represent 80 per cent or more of the total operating costs, the profitability of all models is extremely sensitive to variations in raw material costs. These costs can be lowered by the use of bulk purchase methods with increased outputs and by the installation of machinery to recycle the 15 per cent of unavoidable plastics scrap which would otherwise be wasted. Small scale extrusion can be profitable but it requires a very careful study of the market to identify a line which is not adequately covered locally by the products of the large firms who may have all the economies of scale in their favour offset only by heavy distribution costs. If an investment in the manufacture of plastics blown film, sheet and pipe is under consideration, the narrowness of the anticipated profit margins makes it essential that expert advice is obtained and a full scale feasibility survey based on local costs is undertaken before any investment decision is made.

SOMMAIRE

L'extrusion de films, feuilles et tubes plastiques

Le présent rapport fait partie d'une série d'études économiques destinées à servir de guide, dans les pays en voie de développement, lors des prises de décisions concernant le choix d'investissements. Peu d'études ont été consacrées à la possibilité de développement d'une industrie des plastiques dans les pays en voie de développement, en particulier à l'aspect économique du matériel et de l'exploitation d'une installation de transformation des matières plastiques. Le présent rapport traite de l'extrusion de polyéthylène de faible densité, connu sous le nom de polythène, pour la production de films, feuilles et tubes souples, et de l'extrusion de chlorure de polyvinyl – PVC – pour la fabrication de tubes rigides.

Il est prévu que la demande en plastiques extrudés, dans les pays en voie de développement, va faire l'objet d'un accroissement rapide, en particulier pour les produits applicables à l'agriculture. Les films et feuilles plastiques conviennent à de nombreuses applications: outre l'emballage, ils peuvent servir au recouvrement des terres, à la protection des plantes, au revêtement de canaux d'irrigation et au stockage des récoltes. Les tuyaux en plastique rigides ou souples peuvent être utilisés pour l'alimentation en eau, le drainage et l'irrigation. Il est très probable qu'une production locale de tuyauterie en plastique contribuerait à encourager le développement de systèmes d'irrigation goutte à goutte dans bien des pays en voie de développement.

Le procédé d'extrusion est un procédé continu, en ce que la matière plastique est alimentée en continu dans une machine; à l'intérieur de celle-ci se produit la compression de la matière, et par là, son échauffement et sa plastification. La matière plastique est alors exprimée au travers d'un moule qui donne le profil voulu. Il faut alors faire passer ce profil plastique ferme par une zone de refroidissement où en sera réalisée la solidification sans déformation du produit. Le plastique est alors coupé, enroulé ou embobiné suivant la nature du produit. Le prix d'une extrudeuse dépend du degré de flexibilité et de l'automatisation opératoire qu'elle offre. L'extrusion peut également être un procédé intermédiaire avant moulage ou formage; il arrive souvent que le coût du matériel de post-extrusion soit plus élevé que le coût de l'extrudeuse.

Il semble que, parmi les différentes extrudeuses construites à l'heure actuelle, l'extrudeuse à vis unique soit plus répandue que les machines à double vis. Les extrudeuses à vis unique sont capables de transformer la quasi-totalité des thermoplastiques au coût le plus bas par livre de matière. Les longueurs de cycles sont l'élément déterminant de la dimension de l'unité d'extrusion: pour des cycles longs, il est recommandé d'utiliser une seule extrudeuse à rendement élevé, combinée à un matériel automatique de calibrage et d'éjection. Il est plus économique, dans le cas de changements de produits fréquents — qui, avec une seule machine de grande dimension provoqueraient une grande quantité de déchets — d'utiliser plusieurs petites extrudeuses.

Quatre des modèles de coût présentés dans ce rapport sont basés sur le rendement d'un extrudeuse à vis unique, de 60 ou 90 mm de diamètre, produisant films soufflés, feuilles et tubes. Deux autres modèles servent à expliquer l'effet, sur les coûts de production, de l'addition d'une seconde extrudeuse aux chaînes de films soufflés et tubes. Le fait de doubler la production ne signifie pas une augmentation proportionnelle de la main-d'oeuvre requise; il est possible, en effet, à un seul opérateur de surveiller plusieurs extrudeuses automatiques à la fois. La main-d'oeuvre totale minimum requise pour tous les modèles de coût se maintient à 10 personnes environ, y compris trois superviseurs disposant d'une bonne compétence technique. Les rendements varient entre 500 et 1 200 tonnes/an, avec postes continus pour 300 jours de l'année. Une superficie couverte de 200 m^2 suffit à une installation de deux chaînes d'extrusion de films soufflés ou tubes, et 350 m^2 à l'extrusion de feuilles. La chaîne de films soufflés demande un bâtiment de 6 à 8 m de haut capable de contenir la tour de refroidissement. Les investissements en capitaux requis pour les six différents modèles varient entre £40 000 et £120 000 et comprennent les investissements en terrains, bâtiments, matériel véhicules et capital d'exploitation pour trois mois d'exploitation qui varie entre £18 000 et £47 000.

Etant donné que le coût des matières premières représente 80% ou plus du total des coûtes d'exploitation, la rentabilité de tous les modèles se ressent considérablement de toutes variations de coût des matières premières pouvant se produire. Il devrait être possible de réduire le coût des matières premières par des achats en volume avec rendements accrus, et par l'installation d'un matériel capable de recycler les 15% de déchets inévitables qui, autrement, ne serviraient à rien. L'extrusion à petite échelle peut être rentable, mais elle demande une étude approfondie du marché visant à trouver l'article n'étant pas produit en quantités suffisantes par les grosses entreprises de l'endroit, qui jouissent des avantages créés par leur envergure, et ne souffrent que de coûts de distribution élevés. Il est essentiel, au cas où serait considérée la possibilité d'investissements dans la fabrication de films soufflés, feuilles et tubes en plastique, d'avoir recours à l'assistance de conseillers techniques experts et d'établir une étude de faisabilité en grand basée sur les coûts locaux avant de prendre la décision d'investissement finale.

RESUMEN

Extrusion de peliculas, laminas y tubos plasticos

El presente es uno de los informes de una serie de estudios económicos destinados a servir de orientación para la adopción de decisiones de inversión en países en vias de desarrollo. Es poco lo que se ha escrito respecto a la industria de los plásticos en el contexto de los países en vías de desarrollo, especialmente en lo que atañe al aspecto económico del equipamiento y operación de una planta elaboradora. Este informe trata de la producción de plásticos extruídos en los que se usa polietileno de baja densidad, también llamado politeno, para la fabricación de películas, láminas y tubos flexibles, y cloruro de polivinilo — conocido como PVC — para la fabricación de tubos rígidos.

Se prevé que la demanda de plásticos extruídos, sobre todo para aplicaciones agrícolas, habrá de experimentar un rápido incremento en los países en desarrollo. El plástico en películas y hojas tiene una variedad de usos, aparte del empaquetado, tales como recubrimiento de suelos, protección de plantas, revestimiento de canales de irrigación y almacenamiento de cosechas. Los caños de plástico, ya sea en su forma flexible o rígida, pueden emplearse para la red de abastecimiento de agua, desagües e irrigación. Es probable que en muchos países en desarrollo se estimule la difusión de sistemas avanzados de riego por aspersión si la obtención de tubos plásticos pudiera hacerse más asequible al producirlos localmente.

La extrusión es un procedimiento de fabricación continua en que se alimenta continuamente material plástico a una máquina que lo comprime haciendo elevar su temperatura, con el consiguiente ablandamiento del material, el cual es forzado a través de una hilera que confiere al plástico el perfil deseado. Este perfil firme del plástico debe pasar luego al sector de enfriamiento para que se solidifique sin alterar la forma del perfil. A continuación se corta, arrolla o bobina, dependiendo del producto de que se trate. El costo de una máquina extruidora varía según el mayor o menor grado de adaptabilidad y automatización de funcionamiento provistos. La extrusión puede ser un proceso intermedio que precede a diversos procedimientos de moldeado y conformación, siendo frecuente que el costo de los equipos que cumplen tareas posteriores a la extrusión sea superior al de la misma máquina extruidora.

Entre los distintos tipos de máquina extruidora disponibles observamos que el tipo de tornillo único es más popular que el de doble tornillo y que las máquinas de tornillo único pueden prácticamente extruir toda la gama de materiales termoplásticos al costo mínimo de inversión por libra. La longitud de la tirada es un factor crítico para determinar el tamaño de la extruidora: para tiradas largas se recomienda una extruidora de tornillo único de alto rendimiento, en combinación con equipos automatizados de tamañado y salida. Si hubiera frecuentes cambios de producto, la proporción de residuos será elevada al usar una máquina grande, en cuyo caso resultaría más económico emplear varias extruidoras pequeñas.

Cuatro de los modelos de costo que se presentan en el informe están basados en el rendimiento de una sola máquina extruidora, ya sea de 60 mm ó 90 mm de diámetro, que produce película soplada, láminas o tubos. Otros dos ejemplos ponen de relieve el efecto que tiene sobre los costos agregar una segunda máquina extruidora a las líneas de película soplada y tubos. El aumento de rendimiento al doble no significa un aumento proporcional de la mano de obra, puesto que un operario puede atender varias extruidoras automáticas, y además el total de gente que cualquiera de los modelos necesita como mínimo se mantiene en unas diez personas, incluídos tres supervisores técnicamente competentes. Los rendimientos oscilan entre 500 y 1 200 toneladas métricas por año, en base a turnos de trabajo que cubran las 24 horas del día durante 300 días del año. Una planta fabril con 200 m^2 de superficie será adecuada para dos líneas de película soplada o de extrusión de tubos, y una superficie de 350 m^2 para extrusión de láminas. La línea de película soplada requiere una construcción de 6 a 8 m de altura para dar cabida a la torre de enfriamiento. El total de la inversión de capital para los seis modelos oscila entre £40 000 — y £120 000 — incluyendo inversiones en terrenos, edificios, planta, vehículos y capital circulante para tres meses de gastos de explotación que oscilan entre £18 000 — y £47 000.

Dado que el costo de la materia prima representa un 80 por ciento a más del total de los gastos de explotación, la rentabilidad de todos los modelos es sumamente sensible a las variaciones en el costo de la materia prima. Estos costos pueden reducirse valiéndose de métodos de compra por volúmenes grandes con aumento en los rendimientos, y mediante la instalación de maquinarias para el reprocesamiento del inevitable 15 por ciento de residuos plásticos que de otro modo se perderían. La extrusión en pequeña escala puede ser rentable, pero exige estudiar muy cuidadosamente el mercado para individualizar una línea inadecuadamente cubierta localmente por los productos de las empreasas grandes, las que pueden tener en su favor todas las ventajas de trabajar en gran escala aunque contrarrestadas por elevados gastos de distribución. Lo restringido de los márgenes de ganancia previstos para la industria de plásticos en forma de película soplada, láminas y tubos, hace indispensable obtener asesoramiento profesional experto y realizar un estudio de factibilidad a plena escala basado en los costos locales, como paso previo a la adopción de decisiones de inversión en una empresa de esta índole.

Chapter 1

The purpose and scope of the report

INTRODUCTION

This series of economic studies of industries is designed to provide guidance for investment decisions in developing countries. With world production and consumption of plastics continuing to increase at phenomenal rates, this subject was an obvious one for inclusion in the series. Little has been written about the plastics industry in the context of the less developed countries and particularly lacking is guidance on the economics of equipping and operating a processing plant.

Because of the high fixed capital costs, investment in plastics raw material production is usually undertaken by national governments or international corporations. On the other hand, plastics fabrication is carried out on a much smaller scale than raw material production and consequently this report is limited to the fabrication sector of the industry. An attempt to produce a report containing meaningful costings for all the main processing techniques would have culminated in a lengthy report containing much information that would have been out-dated before publication. A shorter more limited report on one main processing method was considered appropriate and after a detailed study of various reports and statistics, the extrusion process was selected.

CHOICE OF PROCESS: EXTRUSION

The process of extrusion was selected for the following reasons:

(a) It is reasonable to assume that extruded products will constitute an increasing percentage of plastics production in developing countries in the future. At present it appears the injection moulding of thermoplastics and compression moulding of thermosetting plastics account for a greater proportion of total production in industry in developing countries than in Europe.

(b) Present experience in developing countries is more limited in this field than in injection or compression moulding and little has been written on the economics of the extrusion process.

(c) The initial capital cost for extrusion plant is greater than for small injection machines and involves a more difficult investment decision owing to the line nature of production. Whilst the extruder itself can be relatively flexible in terms of product mix, the ancillary equipment is often suitable for the production of one product only and in some cases only one size of product.

(d) The range of available machinery is very wide in terms both of output and price although few manufacturers appear to offer a complete range of scales.

(e) The product range is much more limited than for compression or injection moulded articles. The main extrusion products could be termed loosely as intermediate goods for which there are more easily defined market prices. This should enable realistic profitability calculations with a fair degree of general applicability to be calculated.

(f) Extrusion products, in particular film, sheet and pipe of polyethylene (PE) or polyvinylchloride (PVC) are of growing importance in various sectors of the economy such as building construction, food packaging and agriculture. This makes them particularly important in developing economies where import substitution, industrial diversification and the development of commercial agriculture are desired as contributions to economic growth. In their relation to food production, storage and preservation they are fairly closely related to other areas of this Institute's work.

(g) The plant being fairly expensive, profitability depends in large measure on the length of time production continues without change of product or interruption and this involves shift working. Many developing countries are interested in setting up such plants but the importance of these problems must be assessed in order to discourage the establishment of uneconomical plants and so avoid wasteful allocation of capital resources.

THE PRODUCTS OF EXTRUSION

Within the terms of reference of this report the production of extruded plastics for use in agriculture will be the main subject, film, sheet and pipe being the particular products to be studied.

The uses of plastics in agriculture are extremely diverse now but in spite of this it appears that film or sheet of a limited range of thicknesses is the most common basic material. It is usually bought by agriculturists and horticulturists who adapt it for various applications which include mulching, 'tunnel' or greenhouse coverings, irrigation channel linings, linings for crop storage units, equipment and animal protection, and several others. These uses are obviously more widespread in the USA and Europe but agricultural applications are also increasing in such countries as Algeria, Morocco, Cuba, Arabic Republic of Egypt, Israel, India, Ceylon, Kenya and West Africa. Film and sheet are also being employed in the constructional and industrial spheres particularly for protection and packaging.

Plastics pipes and tubes* in flexible or rigid forms have equally diverse uses. Standards for rigid plastics piping have been established which are encouraging acceptance for use in domestic and mains water supply and for guttering and drainage purposes. Large amounts of flexible pipe are used in factories, on building sites and now increasingly for irrigation. In this use its initial higher cost in comparison with traditional open channel methods is offset by ease of installation using unskilled labour, reduced maintenance costs, water saving owing to increased control over distribution and increased flexibility. It is probable that the successful development of trickle irrigation systems for bush or tree crops would be encouraged in many less developed countries if pipe could be made more easily available through local production and efficient marketing methods.

OUTLINE OF THE REPORT

The report covers a relatively narrow field and is principally concerned with the economic and techno-economic aspects of plastics extrusion, the end products being film, sheet, pipe and tubing. The emphasis of the report will be on the way in which the technical characteristics of the plant affect the cost of the products. The specimen costings have been based on local factor costs and data obtained from South-East Asia, mainly Malaysia. This area seems appropriate in terms of size of population, urban structure, level of agricultural development and level of income insofar as it could support a small number of extrusion plants. No plants producing pipe are known to exist in Malaysia at present but firms producing film and sheet are already established.

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* The term 'pipe' is that most commonly used in the industry, 'tube' being normally used to describe the narrow gauge pipe such as that used in instrumentation systems.

No attempt has been made to cover the purely technological aspects of the subject since the intention is to focus solely on the economic problems and in any case much has already been written in this field. Some books on the subject are listed in Appendix 3.

COSTINGS: A PRELIMINARY CAUTION

It must be very strongly emphasised that the costings included in this report and described in Chapters 3 and 4 relate to one geographical area only and cannot be regarded as an accurate guide to the likely profitability of any given project. In every instance where an investment in extrusion equipment is under consideration, a full-scale feasibility survey based on local factor-costs will need to be undertaken.

Chapter 2

Outline of process and products

EXTRUSION

Extrusion is a continuous process whereby plastics (usually thermo-plastics) material is fed continuously into a machine where it is compressed causing it to become heated and thus plasticised and from which it is expressed through a die head which imparts the desired profile to the plastics material. The technical efficiency of any extruder can be evaluated in terms of its basic function of delivering to the die head a uniform supply of molten polymer at uniform conditions of temperature and pressure. This firm plastics profile must then be delivered to the cooling area for solidification without distortion to its shape. It is then cut, reeled or coiled according to the particular product.

The three basic stages connected with extrusion are:—

1. the plasticisation and forming in the actual extruder
2. cooling and calibrating
3. take-off

The exact equipment used will of course vary according to the raw material being used and the product being manufactured. The extruder itself will not necessarily be suitable for a range of products or raw materials. Extruders which are flexible in terms of possible products and feed materials can be obtained only at a higher price than less flexible equipment. The higher price reflects the greater range of operating temperatures, pressures and screw speeds that must be available to give this flexibility. This is probably the most important techno-economic relationship requiring evaluation prior to an investment decision in an extrusion plant; it is necessary to weigh the economic value of increased flexibility of output against the increased costs incurred thereby. Essentially these are capital costs but the more flexible machinery may also be more expensive to service and maintain and may require an additional service engineer.

The price of an extruder will depend in large measure on the degree of automation and mechanisation provided, and this is also true of the ancillary equipment. The investment costs of the post extrusion equipment is often equal to or greater than the cost of the extruder. Each of these points must be considered not only on its own merits but also in relation to its effect on the quality of the product.

Extrusion can be an intermediate process before blow moulding, vacuum forming and film coating production. This makes diversification possible once extrusion is being carried out successfully. In most developed countries, however, there are no mixed product plants; one firm might produce a range of films of different widths and gauges while another produces a selection of pipe sizes. There has been a great deal of vertical integration by the large companies.

THE EXTRUDER

Of the several types of extruder available, it appears that the single screw type is more popular than the twin screw type and these machines can extrude virtually the complete range of thermoplastic materials at the lowest investment cost per pound. Twin screws are used mainly in Europe for extruding PVC and for pipe manufacture but have a higher cost and are more expensive per unit of output. Single screw extruders are considered to be more reliable and have greater output. The size of the extruder is dependent upon the product required and the nature of the forming and cooling equipment to be used. Usually the cooling rate is the bottleneck of the system and it may be necessary to choose an extruder to suit the cooling equipment rather than vice versa.

Length of run is critical in determining size of the extruder; for long runs a high output single screw extruder together with automated sizing and take off equipment is recommended. If, on the other hand, there are frequent change-overs in product, larger-scale equipment is difficult to justify. A problem with the bigger machines is that frequent shut-downs generate large amounts of scrap. If the producer plans for a large product mix, several small extruders are preferable to one or two large machines. Custom extrusion firms normally operate 2½ in. (60 mm) or smaller diameter machines for the above reasons whilst resin suppliers using extrusion to form the raw material pellets tend to operate with 6 in. (150 mm) or larger diameter screws.

The screw is the essential part of the extruder and screw design is a highly technical and complex matter. Raw materials suppliers will usually advise on the design of the screw suitable for any particular material or materials but it is useful for the investors to be aware of the basic principles underlying the design of the screws. Screws are normally described by the ratio of length to diameter which varies for different raw materials and sizes of extruder.

In the use of a single stage screw, the plastics material is conveyed through the barrel by the screw which basically has three distinct zones. Firstly the feed section takes up the pellets, powder or beads and conveys them forward in the solid state. Generally the machine removes irregularities in the material at this stage. Because of the reduction in bulk effected as the material is moved forward and plasticised, compression must be induced by the screw. Compression also prevents trapped air from being carried forward to the die head. The required compression occurs in the second zone between the feed section and the shallower metering zone. The metering section or output end of the screw generally extends for approximately 25 per cent of the screw length and it is here that the final pressure is developed and the homogenising of the melt is completed.

A two stage screw as distinct from the single-stage type described above, is eqivalent to two screws on a common shaft and is recommended for PVC extrusion. The purpose of this type of screw is to allow volatile gases formed during the compression in the first stage, to escape. A vent or opening is located in the feed section of the second stage of the screw and is normally referred to as the depression zone. Machine manufacturers, in co-operation with the raw material suppliers can provide a properly designed screw for any particular needs if they have all the necessary information on the material, the relative importance of quality and details of the die head and take-off equipment that will be used.

The barrel which surrounds the screw is usually electrically heated and must withstand high pressures. The heating elements are required for start-up but in many cases the internal heat generated by friction will be sufficient once the machine has been running for a short time. The barrel usually has some cooling system — either water or air blown to prevent over-heating which might cause degradation in the plastics melt. Some screws have internal ducts for cooling purposes to stop degradation but these are refinements which less automated machines do not possess and consequently provide less control over the temperature of the melt.

Figure 1

Typical cross section of an extruder

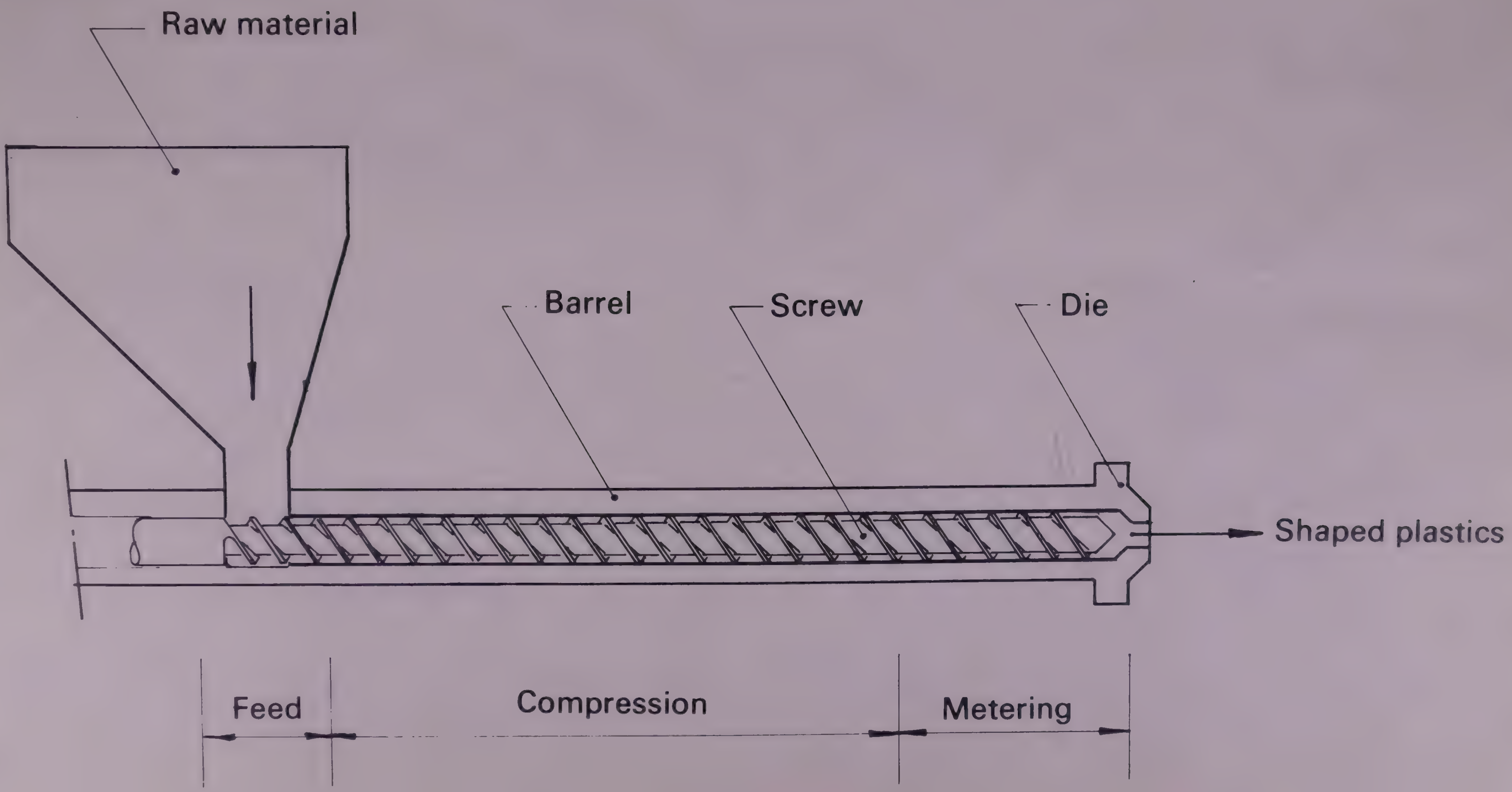

Raw material
Barrel
Screw
Die
Shaped plastics
Feed
Compression
Metering

Figure 2

Extrusion of a pipe

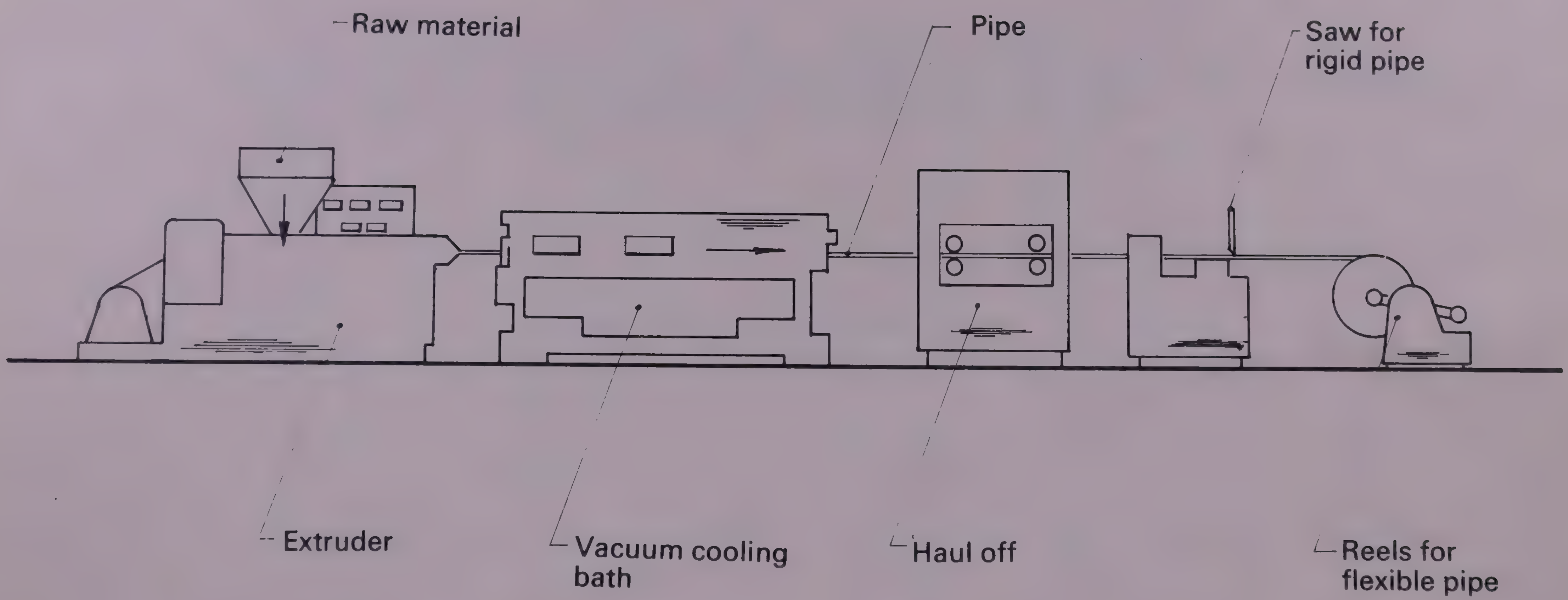

Raw material
Pipe
Saw for rigid pipe
Extruder
Vacuum cooling bath
Haul off
Reels for flexible pipe

Figure 3
Extrusion of sheet

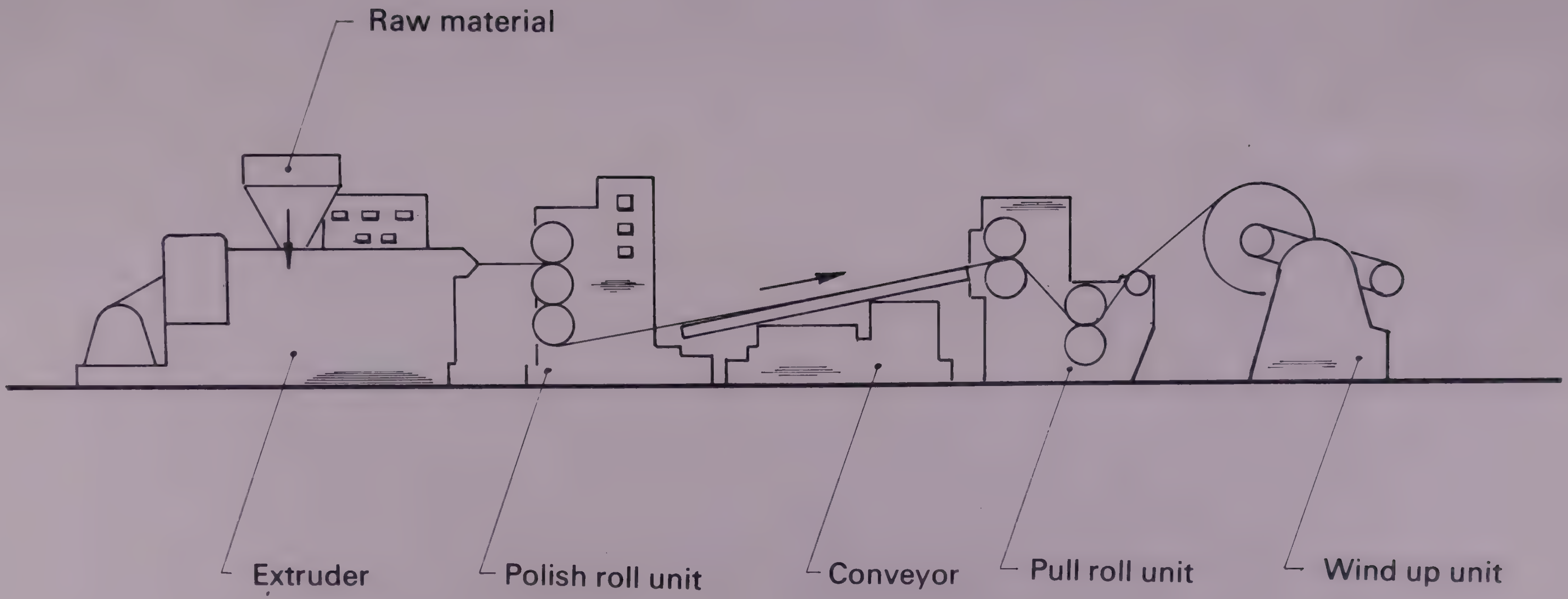
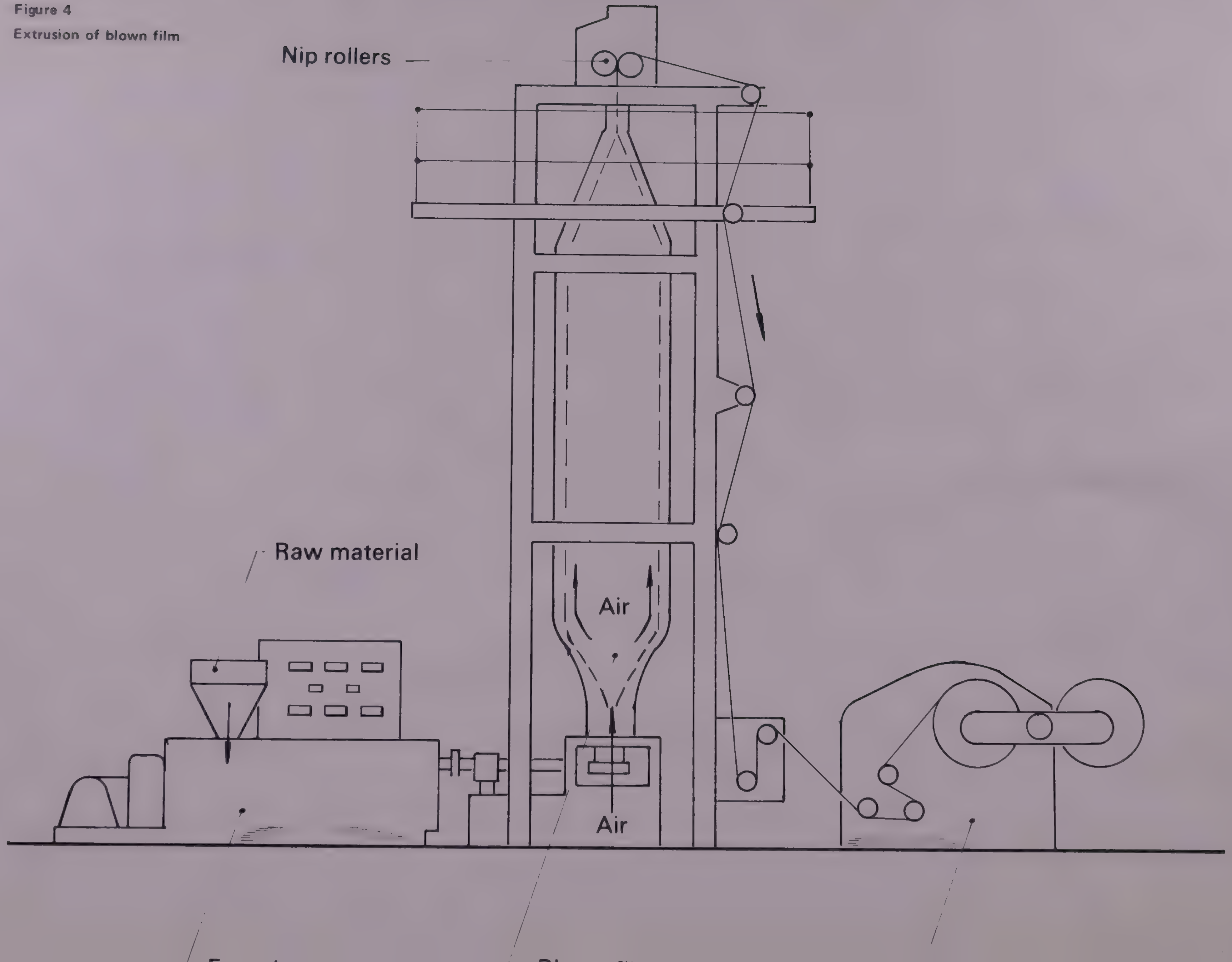

Raw material
Extruder
Polish roll unit
Conveyor
Pull roll unit
Wind up unit

Figure 4
Extrusion of blown film


Nip rollers
Raw material
Air
Air

The die is situated in the head of the extruder and imparts its profile to the molten plastics material; the design and manufacture of dies demands highly skilled techniques and is not usually recommended for developing countries until enough expertise in the plastics industry has been established. From the die head the shaped plastics material is conveyed to the cooling equipment. Because of the variety of the ancillary units available, description of each unit used in the models is deferred until a later chapter.

RAW MATERIALS

Virtually any thermoplastics material can be extruded but some machines may not be suitable for particular plastics partly because of their limited range of screw speeds. This report is mainly concerned with polyolefins and PVC for the products that have been mentioned (film, sheet and piping).

Polyethylene (PE), the most important polyolefin, known as polythene, was developed in 1942. It is odourless and tasteless and its valuable properties include strength, flexibility, resistance to a wide range of compounds, colourability and excellent insulation. PE is graded according to its melt properties and is indexed in terms of its flow. It is available in two basic forms – high and low density which reflect respectively the method of production through low and high pressure polymerisation of ethylene. High density PE is excluded from the terms of reference of this report since it is more difficult to process and has a higher volume cost.

Polyvinylchloride (PVC) has excellent electrical properties, resists weathering and can be manufactured in flexible or rigid forms. Its exact properties vary according to the amount of plasticiser added or the amount and type of co-polymer used. In this instance, rigid PVC will be considered although it needs careful handling during extrusion to prevent degradation.

Polypropylene (PP) and acrylonitrile-butadiene styrene (ABS) may be used for some of the products being considered but only PVC and PE are considered here. The producers of raw materials compound products from formulae which have been specially designed for particular applications. These mixed compounds are either readily available locally or easily imported. Much expertise must be acquired before it becomes possible to produce ones own mix and it is assumed here that correctly mixed compounds will be bought by the extrusion firms.

The compounds are usually produced by large companies in developed countries and it is the excess production which is sold. Because of this, prices fluctuate according to whether there is a surplus or shortage in the relevant exporting country. Small firms whose requirements are too limited to take advantage of the large discounts available on bulk purchases, prefer to carry only two months stock of compounds and to shop around the world for low priced surplus stock. Since the constituents of compounds from different countries often vary, changes in the operating temperatures and pressures may be necessary. Special care is needed to ensure that use requirements, such as ultra-violet light resistance, are satisfied by the new stock.

PIPE AND TUBE

Plastics piping has become an important replacement for traditional piping materials such as steel, asbestos, cement and copper. Its light weight, low cost, excellent chemical resistance, ease of fabrication and low investment cost as compared with metallic and other piping materials, have collectively been responsible for its growing acceptance. Other major applications include irrigation, drainage, oil and gas production and distribution, electrical conduits and domestic cold water supply.

The use of plastics piping may be accepted more readily in developing countries than in Western Europe because of the absence of established metal working practice, unions and other institutional factors that have hindered its acceptance in Europe. The whole market for pipes and piping should be surveyed and the strength and competitive position of the existing traditional pipe materials assessed. In Israel for example irrigation pipes of PE and PVC have been replacing aluminium. Smaller pipe diameters can be used and the pipe is readily transportable. Some countries in South East Asia have begun using plastics piping extensively for electrical conduits and water transportation for domestic supplies, also for irrigation on rubber plantations.

PE pipe, whilst noted for its low cost, light weight and flexibility, has the drawbacks of relatively low strength and structural rigidity and of low softening point but new denser materials have greatly improved its thermal and mechanical properties. The flexibility of PE pipes permits lengths of 100 – 500 ft (30 – 150 m) to be handled from coils and so minimises the number of joints required.

Unplasticised PVC forms rigid pipes with excellent chemical resistance, good weathering properties and is not inflammable. This latter property is particularly important for use in construction.

In recent years, several mechanical jointing systems have been developed which replace solvent welding techniques that required a much longer period of time for setting of the joint. The machinery for extruding pipes is readily available from most equipment producers and requires a relatively low initial outlay. The production of pipe fittings by injection moulding requires a higher initial outlay as well as a higher sales volume and considerable technical expertise. Hence a decision must be made as to whether to produce the fittings locally or whether to import them and merely to produce the pipe locally, this being the bulky product. Care must be taken with dimensional standards which vary considerably from country to country.

Pipe is extruded by forcing molten plastics material horizontally through an annular (ring-shaped) die into a device which cools it and fixes its dimensions. These cooling and calibrating machines are available in several forms and are followed in the line by a puller and a cutter or winder (or both if the extruder is flexible enough for a range of raw materials). The cooling and calibrating unit must be carefully selected to match the output of the extruder – cooling is often the bottleneck of the system and this can cause a lowering in the quality of the pipe.

FILM AND SHEET

Thin gauge film is predominantly produced using blown tubular extrusion methods; flat (or cast) film extrusion processes are used mainly for thicker gauge film and more particularly for sheet products.

Blown film is usually between 0.001 – 0.01 in. thick (approximately 0.025 – 0.25 mm or 25 – 250 μm*) and is either left in its tubular form (lay flat) cr else is gusseted or slit prior to rolling. Sheeting usually has a gauge of 0.005 in. (approximately 0.125 mm or 125 μm and above.

Essentially the method of production of blown film consists of extruding the plastics material through an annular die normally arranged to extrude the melt upwards. This thin tube of plastics material is supported and blown upwards into the wind-off tower by filling it with air injected through a central orifice in the die. The air is trapped by a process in which the film is nipped between rollers at the top of the wind-off tower. The air blast on the inside (and sometimes one on the outside as well) cools the film, a process which is continued by the ambient air. Specially angled boards collapse the tube into the nip-rollers which are a specific distance from the die head for maximum cooling. Winding rollers then reel the film at a suitable speed to prevent tension stretching or puckering the film. A gusseting or slitting unit may be installed between the nip rollers and the winder.

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* 1 μm = 0.001 mm

A sheeting line consists of an extruder with a flat wide mouthed die which extrudes the molten plastics material on to highly polished cooling and supporting rollers. After cooling the sheet is wound up or in the case of thicker sheets is cut to required sizes and stacked on special receiving tables.

Both these products are used in a wide range of applications but this report is mainly concerned with the agricultural uses. Often these products are produced as intermediate goods which are later thermo-formed into other articles. As part of the blown film line a bag-making machine can be incorporated for the production of bags and sacks of varying sizes. Bags of a particular size and quality may be used to collect rubber so replacing the porcelain dishes which have to be emptied every day. The PE bags will hold 14 lb of rubber fluid and need only be collected every 14 days.

In the Cameron Highlands in Malaysia, PE sheeting is being used to help keep the ground dry while in Kuwait sheeting is laid on the ground to prevent evaporation as part of a water conservation campaign.

For the production of film and sheet, only polythene is considered in this report since although plasticated PVC is acceptable it is more expensive on a volume basis than polythene.

The advantage of its marginally increased resistance to puncturing and snagging over polythene is offset by such disadvantages as:—

1. Its low temperature impact resistance is poor.
2. It 'creeps' at elevated temperatures; for example, stacks of sacks become unstable and collapse as PVC gradually elongates and distorts under the effect of pressure and heat.
3. Handling problems are often serious because of 'blocking' (when the inner surfaces of the sack stick together).
4. Economical formulations of PVC may be toxic and many plasticisers used are not free from odours.

ADDITIONAL EQUIPMENT AND FACILITIES

Each line is complete as described although more or less automatic equipment might be considered and this point will be discussed later in the report.

Assuming that British standards will be followed initially, pipe must be indelibly marked at ten ft (3 m) intervals with manufacturers identification, number of British standards specification, grade, size and class. This is certainly advisable but during development stages might be omitted. Quality control for pipe gauge could be undertaken by the plant supervisor.

Prior to wind up, film or sheet that is to be decorated, printed or glued must be electrically treated. The normal chemical and molecular structure of the film gives its surface a low adhesion factor and causes the ink to peel off. In treating the film, it is subjected to a high voltage discharge thus chemically modifying its surface. This can be done either by corona-discharge or by electron beam.

Printing on these surfaces can be done in several ways; namely gravure, hot stamping or flexographic; in the early stages of a project this operation could, however, be omitted to reduce investment outlay. Initially felt pens can be used to mark batch numbers, places of destination, etc.

There should be some quality control but initially this could be fairly elementary and organised by the plant supervisor. The type of tests for film should include:—

1. drop test to measure impact strength.
2. snag resistance.
3. strength of seals by measuring air pressure required to burst sack, the ultimate tensile strength across a strip which includes the seal should be 70 per cent of the average ultimate strength of the film.
4. tear strength by measuring the energy required to propagate a tear rather than initiate it.
5. coefficient of friction measured by the normal inclined plane technique.

Later control tests such as those suggested by the British Standards might be adopted until the time when the country concerned sets up its own standards. The establishment for the plastics industry of a research institute, training centre and technical library should be encouraged; research into the particular requirements of the country might be undertaken at a later stage but in the meantime these institutions could keep abreast of developments whereas individual firms could not. Very important in the field of research at the present time is the question of disposal of plastics items and any development in this field should be made known as soon as possible. Another function of these institutes would be to increase the extent of technical knowledge of the processing machinery. For extrusion the establishment of an organisation producing dies would be of enormous benefit and likewise for injection moulding if it were feasible to manufacture particular moulds locally.

After some time gaining production experience using ready compounded mixes individual formulae might be worked out to suit specific conditions found in the particular country. For example in the tropics the incidence of fungus growth, high temperature, high humidity, intensely bright light and the presence of insects and termites might necessitate the adaptation of the compound. Compounding requires a blending machine to ensure absolute integration of all the constituents. Special care must be taken to check whether any of the constituents of the new compound are hygroscopic (tend to absorb water) and if this is so a drying cabinet must be installed to ensure that no moisture is taken into the extruder with the plastic raw material. Moisture can cause steam bubbles in the molten plastics material and these come out as points of weakness in the product. In any event, the raw materials must be stored in dry conditions and where possible low storage temperatures should be avoided owing to the likelihood of water being deposited on the surface of the raw material when it is brought into the warm production area. In large companies air conditioning is installed to ensure a steady temperature and adequate ventilation but this is not usually possible for smaller producers and is not essential.

Inevitably in any process scrap is produced and extrusion is no exception but thermoplastic scrap can be reused. If it is pure it can be granulated and mixed with 80 per cent new material and re-extruded. Alternatively regranulated scrap can be sold to injection moulding firms. Machines are available to regranulate scrap and are definitely recommended as raw material costs are a large percentage of total costs.

Factory service items in an extrusion plant should include lifting facilities such as a hoist to enable the screw to be removed, trolleys to carry the extruded product and drainage to allow hosing down of the floor to settle the dust. For safety, carbon dioxide fire extinguishers must be prominently placed as well as first aid boxes. Asbestos or heavy cotton gloves, safety shoes and face shields ought to be available. Warning signs and insulation must be obvious and effective. Adequate precautions against electrostatic build-up must also be taken, tinsel being a suitable material for draining off the charge which collects as the film is being wound up. Cleaning and maintenance equipment is necessary but these points will be discussed more fully in the next chapter.

PLASTICS DEGRADATION AND WASTE DISPOSAL

It has long been known that ultra-violet light from the sun causes a gradual breakdown of plastics compounds leading to a loss of plasticity, brittleness and eventual slow decomposition. However the normal rate of decomposition of plastics material from standard formulations is too slow when compared with the rate of accumulation of waste plastics wrapping materials and containers, particularly in urban areas. The world is now facing a major problem in the pollution of its surface by an increasing accumulation of plastics packaging waste. Several commercial applications of light-degradable plastics have been introduced. These work by means of the addition of a light sensitive substance to the plastics material, which catalyses the decomposition of the plastics products after a certain amount of exposure to light. Once this decomposition has started, it continues even in the absence of light at a rate which can be controlled by the nature of the original formulation.

Some plastics products such as irrigation piping and sheeting may be exposed to continuous tropical sunshine and for these uses long lasting plastics are specially formulated to withstand a high degree of exposure to light without undergoing measurable decomposition. The stability of these products will obviously conflict with the desirability of easy waste disposal. It is hoped that eventually the bulk of the world's plastics waste will be either readily degradable or else capable of being re-cycled.

CHAPTER 3

Design of models

ECONOMICS OF SCALE

There are many potential combinations of equipment and possible levels of output but the nature of these reports limits the number of models that can be presented; those included have been chosen to highlight the most important cost characteristics of the industry.

The plastics fabrication industry is characterised by small independent specialised units each aiming to achieve full utilisation of a small plant with a limited range of products. Figures from the USA suggest that plant size does not greatly affect the percentage breakdown of the final product average cost. Nor is plant size reflected in profit rates. Probably the biggest general problem facing the smaller units is their relatively weak financial position from the point of view of obtaining capital funds for expansion. Sometimes these manufacturers act as sub-contractors to larger firms who will often assist by providing equipment, finance and credit, will give technical assistance and will offer long term contracts. For the purposes of this report no close links with other firms are assumed although a long term contract might have considerable advantages for film and pipe producers. The main advantage is the stability and predictability of future income that such a contract affords. This enables better forward planning of both financial and technical aspects to be carried out.

Most of the research and development involved in the fabrication of finished products is undertaken by the manufacturers of plastics material. Only about one fifth of the relevant research and development is carried out by the fabricators and these are generally the larger firms using plastic in highly advanced applications in the engineering field. This is a considerable advantage for the small-scale firm wishing to establish itself in a developing country. Generally speaking expert advice is available from the large raw material suppliers and consumers themselves can be consulted on the types of product required. When the costs of production of film on a small and large extrusion machine are studied, the comparison shows substantial economies of scale for depreciation, labour and other works costs.

A cost model for each type of product is illustrated and the effects of various factors such as increased flexibility of plant and additional ancillary equipment analysed. It is relatively easy to evaluate the cost characteristics of a model where the increased flexibility of a plant enable it to be operated throughout the year at the desired number of shifts rather than for part of the year because of a limited market for the plant's main product. However, it is difficult to quantify the advantages of flexibility in a situation where although the market analysis suggests that a plant could operate economically producing its one main product, possible changes in the firm's market and competitive position occurring within the life of the machine might make a product change necessary.

Flexibility can be achieved not only in terms of machinery employed but also in terms of the feed stock (i.e. plastics raw material) used. As the number of raw materials is increased so the costs per unit will rise through increased prices for smaller quantities of particular raw materials, more complex handling and storage systems and inventory control. One major advantage large firms have over smaller concerns lies in the bulk buying of raw materials where substantial discounts are available on large orders. The reduction in risk involved through wider market opportunities must be weighed against the extra cost.

The second important techno-economic relationship concerns the appropriate degree of automation and mechanisation in any particular situation. In pipe extrusion, for example, the lengths of pipe can be cut using a simple hand powered guillotine, a manually controlled mechanical saw or by a fully automatic cutter. Similar choices are open when producing film and other products. The extruder itself can have barrel temperature and pressure controls which are automatic and self regulating or they can be controlled manually. It would seem impossible to make hard and fast rules to assess these choices on any basis except the calculation of the full cost (capital and operating) of the various alternatives. Large extruders (with 6 in. (150 mm) and over screw diameter) are normally fully automated because as a result of the high capital investment long runs are necessary for economic production and automation is advisable. With smaller machines (1 – 2.5 in. (25 – 60 mm) diam.) engaged in short runs less automation might be an advantage although the quality of the product may suffer. It must be remembered that a small extruder cannot produce a good large-gauge product and a large extruder cannot produce a small-gauge product with precision so that if a range of sizes is required a medium size machine would be recommended. Investors must appreciate that these options are available and must be sure that the plant suggested to them by firms really suits the economic characteristics of the market situation in which they are working.

The third relationship concerns the quality and price of the plastics product. Quality can be varied according to the user's exact requirements but it is important that the finished product is competitive with more traditional materials particularly in the field of piping where quality must be related to any standards specified in the particular country even if these are not compulsory. The value of a central organisation laying down standards (similar to the British Standards Institute and the French National Quality Control Mark 'PF') is even greater in developing countries where users may not have the full technical knowledge to evaluate the products themselves. Such a 'stamp' also acts as a barrier to deterioration of quality under a regime of price competition and as a bridge between producer and consumer particularly in the acceptance of new products. The relationship between quality and price will affect the initial investment decision in terms of the complexity of quality control introduced and of the accuracy of calibration used. It will also affect operating costs in terms of the quality of the raw material used and the extent to which waste materials can be reintroduced into the extrusion cycle.

The product price should be based on the actual price of equivalent imported or home produced items. Prices of lower quality goods should show a clear margin below the cost of higher quality products. Import substitution may involve tariff protection at the initial stages.

It is usually suggested that the capacity of the machine should be 50 per cent greater and the horse power 25 per cent higher than was originally required. This allows for measured expansion before further machinery needs to be purchased.

DESCRIPTION OF MODELS

In each of these models a 300 day year is assumed, three 8-hour shifts being worked per day. Maintenance is assumed to take place on the weekly rest-day but extruders can normally be run for between 30,000 – 50,000 hours before repairs are necessary and they often operate satisfactorily for much longer. The operating efficiency of most extrusion operations is in the region of 85 per cent and this figure is used for these models. This allows for shut downs for such purposes as die or screw changes (the time involved usually being around 20 and 35 minutes respectively). Start-up normally takes about 4 hours while replacement of the the take-off reels can normally be done in a few minutes by a skilled operator.

Each factory building should have asbestos roofing as a fire precaution.

Special provision has to be made for the blown film building which must be 20 – 25 ft (6 – 8 m) high to accommodate the tower unit. Mains services are laid on and a small area of the factory building is required for office space and a laboratory. Storage of the raw material is distributed in low stacks around the factory floor. The raw material which is packed in bags each containing 25 kg is fed straight into the hopper.

Owned transport is advisable because of the large volume to weight ratio. Dusty conditions must be avoided as the static electricity on the film, sheet or pipe attracts dust and packaging is suggested wherever possible. Packing is particularly recommended for film and sheet so as to guard against scratching and often the kraft paper bags that contained the raw material can be re-used for the output.

The choice between extruders of different size was narrowed to two: the 2.5 in. (60 mm) and the 3.5 in. (90 mm) and examples of both are illustrated in the models.

As many factor costs as possible were gathered from Malaysia and machinery costs are as quoted by manufacturers. Second-hand machinery is obtainable but increased repairs and maintenance might be a disadvantage in a developing country and only new equipment is considered in this report. Faults in an extruder fall into two categories, namely mechanical or electrical failures, and electronic faults, each of which need separate engineers to deal with them.

Water treatment equipment has not been included because it is unnecessary in Malaysia and as sufficient water is available there is no need to recirculate water for cooling purposes and therefore no refrigeration unit is required. In the event of water shortage the latter alternative will be required for the cooling of extruded pipe.

The machinery used in this report is mainly automated in design and should produce high quality products. Less automated extruders have the disadvantages of producing lower quality goods. A lower degree of automation could be included in the ancillary equipment but the quality of the product may suffer. This point is discussed in the next chapter on page 25.

THE MODELS

Model A1: Blown film line

In this model a 2.5 in. (60 mm) extruder is used to produce low density polyethylene lay-flat tube up to 44 in. (1 120 mm) maximum width and up to 900 gauge (0.009 in. (230 μm)) maximum thickness. A typical output rate from the line used is 45 000 ft (13 716 m) lay-flat tube 21 in. (530 mm) wide and 250 gauge (0.025 in. (63 μm)) thick per 8 hour shift. Width of the tube is governed by the diameter of the die and in general the maximum width obtainable can be estimated as two and a half times the diameter of the die. One manually operated bag and sack making machine has been included to indicate the production possibilities. Four of these machines could cope with the total output of one blown film line or they could be replaced by fewer semi-automatic machines, costing about £5 000 each.

Model A2: Two blown film lines

This model differs from A1 only insofar as the output is doubled. The resultant effect on unit costs is studied in the next chapter.

Model B: Sheet line

A 3.5 in. (90 mm) extruder is used to produce low density polyethylene sheet approximately 36 in. (915 mm) trimmed width. The sheet width is dependent on the width of the lip of the die and in this case a 40 in. (1 016 mm) die is used. One manually operated sack making machine has been included to indicate the production possibilities. Alternatively, a semi-automatic machine could be installed as in Model A1.

Model C: Pipe line

This line is based on a 3.5 in. (90 mm) extruder and is equipped to accept both low density polyethylene and rigid polyvinylchloride with half the annual production time devoted to each product. Pipe of up to 4 in. (100 mm) internal diameter can be produced.

Model D1: Pipe line

In this model a 2.5 in. (60 mm) extruder is used for the production of low density polyethylene pipe of up to 4 in. (100 mm) inside diameter when a continuous feed system would probably be necessary.

Model D2: Two pipe lines

This is an extension of Model D1 which illustrates how production costs are effected when output is doubled.

All models

Table 6 in the appendix gives typical hourly outputs from the two sizes of extruder used in this report. These rates should be achieved in the applications being considered although there are occasions when the efficiency of the ancillary equipment may preclude utilisation of the full capacity of the extruder.

CHAPTER 4

Interpretation of cost models

PURPOSE OF COST MODELS

It will be appreciated that although the cost models presented in the tables are based on information obtained from Malaysia, the costs prevailing there will by no means be typical of all countries where the establishment of a plastics industry is contemplated and the models are therefore only illustrative, as was stressed on page 8. Their purpose is two-fold, namely to provide in a convenient form details of physical factor inputs, and to indicate the basic method of applying local factor costs to these inputs. From them it should be possible to obtain an approximate indication of the relative sensitivity of the project to changes in cost of the various inputs. It is worth mentioning here that none of the cost models is directly based on the actual performance of any of the existing plastics plants in South-East Asia.

In Table 1 the total capital investment, annual operating costs, rates of return and capital pay-off period are presented comprehensively for each model. Subsequent tables provide a breakdown of the basic information used for the compilation of Table 1.

RATE OF RETURN

As calculated in the tables, the rate of return on invested capital is calculated by expressing annual profit as a percentage of the total initial investment. Two sets of results have been calculated, one based on unadjusted gross profit and the second on gross profit adjusted for company taxation, depreciation and various investment allowances. The system of taxation used approximates to the system currently in force in Malaysia. Since the raw material cost is the dominant item in annual operating costs it was considered instructive to examine the effect on the rate of return of a 10 per cent reduction in raw material cost, and the results are tabulated below:

(Per cent)

		Model A1	Model A2	Model B	Model C	Model D1	Model D2
1	Rate of return (gross profit)[1]	19.0	38.2	40.4	62.3	56.1	102.5
2	Rate of return (gross profit) after 10 per cent raw material cost reduction	34.3	54.3	62.6	96.5	84.3	135.0
3	Rate of return (adjusted profit)[2]	12.0	24.1	25.4	39.3	35.1	64.3
4	Rate of return (adjusted profit) after 10 per cent raw material cost reduction	21.5	34.3	39.4	60.7	52.8	84.7

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[1] From Table 1, row 33

[2] From Table 2, row 34

While the above method is adequate as a preliminary indication of the viability of the project, an accurate and detailed assessment can only be obtained using the discounted cash flow (DCF) method and for the purposes of a full-scale feasibility survey this method is indispensable. Since, however, very comprehensive and accurate cost information is required before a meaningful DCF can be carried out, it was felt that inclusion of this type of calculation in the tables would be inappropriate. The DCF method yields two indications of the viability of the project, namely the Internal Rate of Return and the Net Present Value, each of which has its own particular uses and applications*.

CAPITAL RECOVERY PERIOD

An alternative method of evaluating a proposed investment is to calculate the time taken to recoup the initial capital outlay from annual profits after making allowance for tax and depreciation. It thus represents the time taken to repay the loans advanced for the purchase of capital goods and is calculated by dividing the total initial investment (including working capital) by net profit. It will be seen from the costings that the capital recovery period is generally reasonably short – particularly in the case of model D2 – in spite of the degree of capital-intensity.

The marked effect on the recovery period of a 10 per cent cost reduction in raw material cost is given below, and serves to emphasise further the importance of ensuring that adequate and reasonably reliable sources of raw materials are available:–

Years

		Model A1	Model A2	Model B	Model C	Model D1	Model D2
1	Capital recovery period (Table 1, row 35)	7.4	4.6	5.2	4.3	4.4	2.7
2	Capital recovery period after 10 per cent reduction in raw material costs	4.9	3.4	3.5	2.8	3.0	2.0

OBSERVATIONS

The sensitivity of the project to changes in raw material costs will already have been noted. Raw material costs account for around 80 per cent of annual operating costs and this percentage is only fractionally reduced (i.e. by no more than 1 – 2 per cent) if the raw material costs themselves fall by 10 per cent.

While none of the rates of return are particularly encouraging, Models A2 and D2 provide a useful indication of the effects of doubling production; there is clearly an advantage in spreading overhead costs but the increased capital investment might prohibit small investors from taking this course. In spite of the high capital intensity, however, it is to some extent possible to reduce the capital investment and thereby increase the rate of return. For example, most of the models have been based on automatic handling methods designed to eliminate manual control; while this is suitable in countries where labour is relatively costly, there is, in many developing countries, a good case for using labour intensive methods provided that quality is not sacrificed. There would, however, be a fall in the operating efficiency of the plant. Alternatively, scrap retrieval machinery might be incorporated in the plant, the reclaimed scrap either being reused or sold to an injection moulding firm. Although this would involve an increase in the initial outlay and in labour costs, the 15 per cent raw material wastage would be averted.

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* Further information on this technique please see the bibliography in Appendix 2 (reference books 7 and 8)

The consequent increase in sales revenue, especially in the larger plants (Models A2, B, C, D2) would be over £30 000 and would offset the increase in capital and overhead costs, thereby increasing the rate of return.

Second-hand machinery is not usually recommended on account of the increased possibility of breakdown and of the chances of obsolescence making spare parts unobtainable. The only advantage is the short-term one of lower capital investment.

CONCLUSION

The aim of this report is to give a general picture of the extrusion of plastics products. Before any investment is made detailed consultation with machinery and compound manufacturers will be essential. The basic assumptions regarding market demand and the type of product required will have to be carefully verified.

Table 1

Capital and annual operating costs

Operating 24 hours per day, 300 days per year

Values in £'000 sterling 1972

	Item	MODEL A1 BLOWN FILM One 2.5 in. (63.5 mm) extruder	MODEL A2 BLOWN FILM Two 2.5 in. (63.5 mm) extruders	MODEL B SHEET One 3.5 in. (88.9 mm) extruder	MODEL C PIPE One 3.5 in. (88.9 mm) extruder	MODEL D1 PIPE One 2.5 in. (63.5 mm) extruder	MODEL D2 PIPE Two 2.5 in. (63.5 mm) extruders	Notes
	a	b	c	d	e	f	g	h
I	Capital costs							
1	Machinery costs fob	27.5	55.0	41.0	22.3	10.2	20.4	See pages 35–38
2	Carriage, insurance and freight	2.8	5.5	4.1	2.2	1.0	2.0	10% of initial plant cost (row 1)
3	Handling	0.3	0.6	0.4	0.2	0.1	0.2	1% of initial plant cost (row 1)
4	Installation of plant	1.5	2.0	2.0	1.5	1.0	1.5	Manufacturer's quotation
5	Technical assistance	0.7	0.7	0.7	0.7	0.7	0.7	Technical assistance for a one month period
6	Land	0.3	0.3	0.4	0.3	0.3	0.3	£3 000 per ac (£7 413 per ha)—see Table 4
7	Building costs incl. all fittings in factory	4.2	4.2	7.2	4.2	3.6	3.6	£2 per ft^2 (£21.52 per m^2)—see Table 4
8	Laboratory equipment	0.5	0.5	0.5	0.5	0.5	0.5	Incl. equipment for quality control
9	Factory service items	0.5	0.5	0.5	0.5	0.5	0.5	Incl. hoist, safety and fire equipment
10	Works transport	1.3	1.3	1.3	1.3	1.3	1.3	One 18 cwt (914 Kg) van—see Table 5
11	Spare parts for plant and vehicle	2.6	5.1	3.8	2.2	1.1	2.0	8% of cost of plant (rows 1, 2, 3) 15% of vehicle cost (row 10)
12	Unforeseens	4.2	7.6	6.2	3.6	2.0	3.3	10% of rows 1–11
13	TOTAL FIXED CAPITAL	46.4	83.3	68.1	39.5	22.3	36.3	Sum of rows 1–12
14	Working Capital[1]	20.8	38.3	46.9	37.7	18.1	33.3	3 months operating costs ¼ (rows 20–23)
II	Prime costs							
15	Plastics raw material	69.2	131.2	146.9	132.4	60.8	115.2	See Table 6
16	Transport of raw material and handling	2.0	4.0	4.4	3.2	1.7	3.5	£3 per metric ton
17	Distribution costs	0.2	0.4	0.4	0.4	0.2	0.4	See Table 5 row 7
18	Electricity	3.9	7.6	9.0	7.0	3.0	5.9	See Table 4
19	Water	–	–	17.6	0.4	0.3	0.6	See Table 7
20	TOTAL prime costs	75.3	143.2	178.3	143.4	66.0	125.6	
III	Overheads							
21	Labour (a) indirect	2.4	2.5	2.5	2.5	2.4	2.5	See Table 8
	(b) direct	2.6	2.6	2.6	2.4	2.4	2.6	See Table 8 (incl. insurance, payroll tax and employees fund)
22	Insurance: building, plant and spares	0.3	0.5	0.4	0.2	0.1	0.2	0.7% of value (rows 1, 2, 3, 7, 8, 9, 11) excl. vehicle spares
23	Tax, insurance and maintenance of vehicles	0.1	0.2	0.2	0.2	0.1	0.2	See Table 5 row 9
24	Maintenance: building and plant excl. spares	1.8	3.3	2.7	1.5	0.8	1.4	5% of value (rows 1, 2, 3, 7, 8, 9)
25	Unforeseens	0.7	0.9	0.8	0.7	0.6	0.7	10% on rows 21–24
26	Interest on working capital	2.1	3.8	4.7	3.8	1.8	3.3	10% of 3 months operating costs i.e. 10% of ¼ (rows 20–25)
27	TOTAL annual operating costs	85.3	157.0	192.2	154.7	74.2	136.5	Sum of rows 20–26
28	Depreciation	3.5	6.5	5.1	2.9	1.5	2.7	2% of building (row 7), 10% of plant (rows 1, 2, 3, 8, 9), 20% of vehicle (row 10)
29	TOTAL annual operating costs incl. depreciation	88.8	163.4	197.3	157.6	75.7	139.2	Sum of rows 27 and 28
30	Sales revenue	97.6	195.3	224.8	182.2	88.2	176.4	See Table 6
31	Gross profit before depreciation	12.3	38.3	32.6	27.5	14.0	39.9	Row 30 minus row 27
32	Gross profit after depreciation	8.8	31.8	27.5	24.6	12.5	37.2	Row 30 minus row 29
33	Rate of return on capital before tax and depreciation	19.0%	38.2%	40.4%	62.3%	56.1%	102.5%	Row 32 as percentage of row 13
34	Rate of return on capital after tax and depreciation and adjusted for allowances	12.0%	24.1%	25.4%	39.3%	35.0%	64.3%	See Table 2 row 11
35	Capital recovery period	5.0 years	3.1 years	3.0 years	2.1 years	2.4 years	1.4 years	See Table 2 row 12

Sources
Tables 2–8

Footnotes

[1] Working capital is assumed to be financed by a bank loan

– – –Sub-total

Table 2

Effects of taxation and allowances

Values in £'000 sterling 1972

Item a	Model A1 b	Model A2 c	Model B d	Model C e	Model D1 f	Model D2 g	Notes h
1 Taxable gross profit before depreciation	12.3	38.3	32.6	27.5	14.0	39.9	See Table 1 row 31
2 Annual allowance	3.5	6.6	5.2	2.9	1.5	2.7	See Table 3b row 5
3 Adjusted taxable gross profit	8.8	31.7	27.4	24.6	12.5	37.2	Row 1 minus row 2
4 Company tax	3.5	12.7	11.0	9.8	5.0	14.9	40% of row 3
5 Net profit after tax before depreciation	8.8	25.6	21.6	17.7	9.0	25.0	Row 1 minus row 4
6 Depreciation	3.5	6.5	5.1	2.9	1.5	2.7	See Table 1 row 28
7 Net profit after tax after depreciation	5.3	19.1	16.5	14.8	7.5	22.3	Row 5 minus row 6
8 Total fixed capital	46.4	83.3	68.1	39.5	22.3	36.3	See Table 1 row 13
9 Tax rebate for initial allowances	2.2	4.0	3.2	1.8	0.9	1.6	See Table 3a row 5
10 Total fixed capital adjusted for initial allowances	44.2	79.3	64.9	37.7	21.4	34.7	Row 8 minus row 9
11 Rate of return on capital after tax and depreciation	12.0%	24.1%	25.4%	39.3%	35.0%	64.3%	Row 7 as a percentage of row 10
12 Capital recovery period	5.0 years	3.1 years	3.0 years	2.1 years	2.4 years	1.4 years	Row 10 divided by row 5

Sources
Federal Industrial Development Authority, Malaysia
Tables 3 a and b

Table 3a

Initial allowances* (first year of production only)

Values in £'000 sterling 1972

	Item a	Model A1 b	Model A2 c	Model B d	Model C e	Model D1 f	Model D2 g	Notes h
1	Building cost	4.2	4.2	7.2	4.2	3.6	3.6	See Table 1 row 7
2	Initial allowance rebate	0.2	0.2	0.3	0.2	0.1	0.1	40% of 10% of row 1
3	Plant and installation costs	33.1	64.1	48.5	27.2	13.3	25.1	See Table 1 rows 1, 2, 3, 4, 8, 9
4	Initial allowance rebate	2.0	3.8	2.9	1.6	0.8	1.5	40% of 15% of row 3
5	Total initial allowance rebate	2.2	4.0	3.2	1.8	0.9	1.6	Sum of rows 2 and 4

Table 3b

Annual allowances*

Values in £'000 sterling 1972

1	Building cost	4.2	4.2	7.2	4.2	3.6	3.6	See Table 1 row 7
2	Annual allowance	0.2	0.2	0.4	0.2	0.2	0.2	5% of row 1
3	Plant and installation costs	33.1	64.1	48.5	27.2	13.3	25.1	See Table 1 rows 1, 2, 3, 4, 8, 9
4	Annual allowance	3.3	6.4	4.8	2.7	1.3	2.5	10% of row 3
5	Total annual allowances	3.5	6.6	5.2	2.9	1.5	2.7	Sum of rows 2 and 4

Footnote

*Some typical tax allowances have been included to demonstrate the method but they do not refer to any actual tax structure in South East Asia.

Table 4

Physical requirements

Values in £'000 sterling 1972

Item a	Unit	Model A1 b	Model A2 c	Model B d	Model C e	Model D1 f	Model D2 g	Notes h
1 Size of extruder	in mm	110 x 24 (2 794 x 610)	2 x 110 x 24 (2 794 x 610)	135 x 29 (3 429 x 737)	135 x 29 (3 429 x 737)	139 x 45 (3 531 x 1 143)	2 x 139 x 45 (3 531 x 1 143)	Manufacturer's specifications
2 Floorspace of line	ft m	26 x 6 (7.9 x 1.8)	2 x 26 x 6 (7.9 x 1.8)	75 x 12 (22.9 x 3.7)	60 x 6 (18.3 x 1.8)	45 x 6 (13.7 x 1.8)	2 x 45 x 6 (13.7 x 1.8)	Manufacturer's specifications
3 Floorspace of factory	ft m	70 x 30 (21.3 x 9.1)	70 x 30 (21.3 x 9.1)	90 x 40 (27.4 x 12.2)	70 x 30 (21.3 x 9.1)	60 x 30 (18.3 x 9.1)	60 x 30 (18.3 x 9.1)	
4 Cost of building	£'000	4.2	4.2	7.2	4.2	3.6	3.6	£2.00 per ft^2 (£21.52 per m^2)
5 Land requirements	ac ha	0.1 (0.04)	0.1 (0.04)	0.15 (0.06)	0.1 (0.04)	0.1 (0.04)	0.1 (0.04)	
6 Cost of land	£'000	0.3	0.3	0.4	0.3	0.3	0.3	£3 000 per ac (£7 500 per ha)*
7 Electrical loading for plant	kW	55	110	130	100	43	86	£0.01 per unit
8 Number of lights		18	18	24	18	15	15	50W fluorescent
9 Electrical loading for lighting	kW	0.9	0.9	1.2	0.9	0.75	0.75	£0.03 per unit
10 Water requirements	gal/day '000 l/day	100 (0.5)	100 (0.5)	345 700 (1 572)	7 295 (33)	6 095 (28)	12 095 (55)	See Table 7
11 Number of vehicles		1	1	1	1	1	1	0.9 tonne van (see Table 5)
12 Direct labour	person	7	7	7	6	6	6	See Table 8
13 Indirect labour	person	3	3	3	3	3	3	See Table 8

Sources

Machinery manufacturers
Federal Industrial Development Authority, Malaysia
Data collected in South East Asia

Footnotes

*Land on an industrial estate
Metric equivalents are shown in brackets

Table 5

Transport requirements and costs for distribution of product

Values in £'000 sterling 1972

Item a	Unit b	Model A1 c	Model A2 d	Model B e	Model C f	Model D1 g	Model D2 h	Notes i
1 Vehicles	0.9 tonne van	1	1	1	1	1	1	
2 Cost	£'000 per vehicle	1.3	1.3	1.3	1.3	1.3	1.3	
3 Drivers	person	1	1	1	1	1	1	See Table 8
4 Driver's wages	£'000 per year	0.3	0.3	0.3	0.3	0.3	0.3	See Table 8
5 Quantity distributed	metric tons per year	558	1 116	1 249	903.5	490	980	See Table 6
6 Distance travelled	miles per year km per year	16 000 (26 000)	32 000 (51 000)	32 000 (51 000)	32 000 (51 000)	16 000 (26 000)	32 000 (51 000)	Delivery to adjacent factories on estate or to railhead
7 Cost of petrol	£'000 per year	0.2	0.4	0.4	0.4	0.2	0.4	£0.30 per gal, 24 miles per gal (£.066 per km 8.5 km per l)
8 Spares excl. tyres	£'000 per year	0.2	0.2	0.2	0.2	0.2	0.2	15% of row 2
9 Tax, insurance and maintenance	£'000 per year	0.1	0.2	0.2	0.2	0.1	0.2	Incl. tyres
10 Depreciation of vehicle	£'000 per year	0.3	0.3	0.3	0.3	0.3	0.3	20% of row 2

Sources
Federal Industrial Development Authority, Malaysia
Data collected in Malaysia

Table 6

Quantities and costs of raw material input and product output

Values in £'000 sterling 1972

Item	Unit	MODEL A1	MODEL A2	MODEL B	MODEL C			MODEL D1	MODEL D2
		LDPE[1]	LDPE[1]	LDPE[1]	LDPE[1] [2]	Rigid PVC[2]	Total (f + g)	LDPE[1]	LDPE[1]
a	b	c	d	e	f	g	h	i	j
Raw materials									
1 Quantity used	(a) kg per hour	91	181	204	204	91	–	80	160
	(b) metric tons per year	656	1 312	1 469	734	328	1 062	576	1 152
2 Purchasing price	£ per metric ton	105.5	100	100	105.5	167.33	–	105.5	100
3 Cost	£'000 per year	69.2	131.2	146.9	77.5	54.9	132.4	60.8	115.2
Output at 85% efficiency									
4 Quantity produced	metric tons per year	558	1 116	1 249	624.5	279	903.5	490	980
5 Sales price	£ per metric ton	175	175	180	180	250	–	180	180
6 Sales revenue	£'000 per year	97.6	195.3	224.8	112.4	69.8	182.2	88.2	176.4

Sources
Machinery Manufacturers
Producers of raw materials (e.g. I.C.I.)

Footnotes
—Nil, negligible or not applicable
[1] Low density polyethylene
[2] Production on 150 days per year for each product

Table 7

Water requirements and costs

Item a		Model A1 b	Model A2 c	Model B d	Model C e	Model D1 f	Model D2 g	Notes h
Extruder								
1 Feed section cooling		–	–	–	–	–	–	
2 Barrel section cooling		air	air	closed system	closed system	closed system	closed system	
3 Screw section cooling		–	–	–	–	–	–	
Take-off cooling equipment		air	air					
4 Vacuum calibrating bath		–	–	–				
	gal/hr	–	–	–	300	250	500	
	l/hr	(–)	(–)	(–)	(1 360)	(1 140)	(2 270)	
5 Cooling rolls	gal/min l/min	–	–	240 (1 090)	–	–	–	
6 Hosing down	gal/day l/day	50 (227)	50 (227)	50 (227)	50 (227)	50 (227)	50 (227)	
7 Personnel	gal/day l/day	50 (227)	50 (227)	50 (227)	45 (205)	45 (205)	45 (205)	5 gal (22.7 l) per person per day
8 Total	gal/day '000/day	100 (0.5)	100 (0.5)	345 700 (1 572)	7 295 (33)	6 095 (28)	12 095 (55)	
9 Cost per year	£'000	–	–	17.6	0.4	0.3	0.6	£0.17 per '000 gallons (£0.038 per '000 l)

Sources
Machinery manufacturers
Federal Industrial Development Authority, Malaysia

Footnotes
–Nil, Negligible or not applicable

Table 8

Labour requirements

Values in £ sterling 1972

	Item	Model A1				Model A2				Model B				Model C				Model D1				Model D2			
		Shift			Annual pay	Shift			Annual pay	Shift			Annual pay	Shift			Annual pay	Shift			Annual pay	Shift			Annual pay
		1	2	3	£	1	2	3	£	1	2	3	£	1	2	3	£	1	2	3	£	1	2	3	£
	Indirect labour																								
1	Manager	1			900	1			1 000	1			1 000	1			1 000	1			900	1			1 000
2	Maintenance Engineer	1			800	1			800	1			800	1			800	1			800	1			800
3	Plant Supervisor	1			700	1			700	1			700	1			700	1			700	1			700
	Direct labour																								
4	Foreman		1	1	950		1	1	950		1	1	950		1	1	950		1	1	950		1	1	950
5	Driver	1			300	1			300	1			300	1			300	1			300	1			300
6	Extruding	1	1	1	950	1	1	1	950	1	1	1	950	1	1	1	950	1	1	1	950	1	1	1	950
7	Bag making	1			200	1			200				—				—				—				—
8	Sack making				—				—	1			200				—				—				—
9	Total per shift	6	2	2	—	6	2	2	—	6	2	2	—	5	2	2	—	5	2	2	—	5	2	2	—
10	TOTAL		10		4 800		10		4 900		10		4 900		9		4 700		9		4 600		9		4 700

Sources
Machinery manufacturers
Federal Industrial Development Authority, Malaysia

Footnotes
—Nil, negligible, not applicable

Appendix 1

Lists of machinery for each model (1972 values)

MODEL A1

1. One 2.5 in (60 mm) air cooled extruder with 40 hp drive.
2. Single screw suitable for PE Barrel L/D ratio 24:1.
3. Temperature control board.
4. One 10 in (254 mm) blown film head and die.
5. Air cooling rings.
6. Blown film tower and nip-roll assembly with combined rewinder.
7. Hand operated bag and sack producing machine.

Total cost £27 500.

MODEL A2

This comprises two units of each item listed for A1.

Total cost £55 000.

MODEL B

1. One 3.5 in (90 mm) extruder for thermo plastic compounds. Barrel L/D ratio 25:1.
2. One 3.5 in (90 mm) screw cored for water cooling and suitable for PE.
3. Drive unit for the extruder comprising a 75 hp drive.
4. Control cubicle.
5. Vacuum pump.
6. One pressure transducer and indicator.
7. One melt temperature thermocouple and indicator.
8. Screw ejector.
9. One valved adaptor connection between extruder and sheet die.
10. Sheet die: coathanger manifold design, lip width opening of 40 in (1 016 mm) to produce a trimmed sheet approximately 36 in (914 mm) wide.
11. Support trolley for the sheet die.
12. Polish and pull roll unit suitable for three 12 in (304 mm) diameter polishing rolls.
13. Three 40 in (1 016 mm) face-width, 12 in (304 mm) diameter polishing rolls.
14. One heat exchanger.
15. One edge trimmer.
16. One drive system.

17. Normal duty standard mechanical shear.
18. One two-station winder for 36 in (914 mm) wide PE sheet up to 48 in (1 219 mm) reel size on a 10 in (254 mm) core.
19. One train movement system for moving the entire haul-off equipment.
20. Bag and sack making machine.

Total cost £41 000.

MODEL C

1. One 3.5 in (90 mm) extruder for thermo plastic compounds. Barrel L/D ratio 25:1.
2. One 3.5 in (90 mm) screw cored for cooling purposes and suitable for PVC.
3. One 3.5 in (90 mm) screw cored for cooling purposes and suitable for PE.
4. Drive unit for the extruder comprising a 75 hp drive.
5. Control cubicle.
6. Vacuum pump for fitting to the extruder vent to remove volatiles.
7. Screw ejector.
8. One 0–2 in (51 mm) pipe head.
9. One 2–4 in (51–102 mm) pipe head.
10. One 4 in (102 mm) calibrating bath.
11. Caterpillar haul-off.
12. Automatic travelling circular saw.
13. Coiling unit for PE pipe.

Total cost £22 300.

MODEL D1

1. One 2.5 in (60 mm) extruder.
2. Selection of dies suitable for PE pipe up to 4 in (102 mm) inside diameter.
3. Water cooling trough.
4. Traction unit.
5. Cut off saw.

Total cost £10 200.

MODEL D2

This comprises two units of each item listed for D1.

Total cost £20 400.

Appendix 2

Sources of further information

1. REFERENCE BOOKS

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2. *Applied Plastics and Reinforced Plastics Review,* a bi-monthly journal.
   – address as for *The Plastics Manual.*

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   33 Bowling Green Lane
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4. *British Plastics Year Book* and occasional supplements, *Plastic Materials Guide* and *Plastics Machinery Guide.*
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   – 49 Doughty Street
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6. *Design Engineering—Plastics* Vol. 1, edited by J. D. Beadle.
– Morgan-Grampian Ltd.
Summit House, Glebe Way
West Wickham, BR4 0SL
Kent, England.

7. *Gaps in Technology—Plastics* OECD 1968
– 2 Rue Andre Pascal
Paris 16^e
France.

8. *Working of Plastics*—OECD 1964.
– address as above.

3. ASSOCIATIONS

1. **Rubber and Plastics Research Association of Great Britain**
Shawbury,
Shrewsbury,
Shropshire.

2. **The Plastics Institute**
11 Hobart Place,
London S.W.1

3. **The British Plastics Federation**
47 Piccadilly
London W1V 0DN.

4. **British Committee for Plastics in Agriculture & Horticulture**
5th Floor, Berkeley Square House,
Berkeley Square,
London W1X 5LE.

FINAL NOTE: BRITISH STANDARDS

Full details of *British Standards for plastics* can be found in the Yearbook of the British Standards Institution. [The number of the British Standard for methods of testing plastics is 2782 (1965)]

Appendix 3

Conversion factors

METRIC UNITS	BRITISH IMPERIAL UNITS
1. Linear Measures	
1 m = 39.37 in	1 in = 0.0254 m
1 m = 3.28084 ft	1 ft = 0.3048 m
1 km = 3 280.84 ft = 0.621372 mi	1 mi = 5 280 ft = 1.609344 km
2. Square Measures	
1 m^2 = 10.763911 ft^2	1 ft^2 = 929.0304 cm^2
	1 ft^2 = 0.092903 m^2
1 ha = 10 000 m^2	1 ac = 43 560 ft^2 = 4 840 yd^2
1 ha = 11 959.89 yd^2 = 2.471052 ac	1 ac = 4 046.86 m^2 = 0.404686 ha
3. Measures of Capacity	
1 l = 0.219976 imp gal	1 imp gal = 4.545963 l
4. Weight Measures	
1 kg = 2.204622 lb	1 lb = 0.453592 kg
	1 long ton = 2 240 lb
1 metric ton = 0.984207 long tons	1 long ton = 1.01605 metric tons
5. Electricity	
(a) Power	
1 kilowatt (kW) = 1 000 Watts	1 horse power (hp) = 0.746 kW
1 kilowatt x 1 hour = 1 kilowatt hour (kWh)	
(b) Light	
	Fluorescent lamp emits 50 lumens per Watt

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Tanning of hides and skins

C. J. Lockhart - Smith and R. G. H. Elliott

ly 1974

Tropical Products Institute 56/62 Gray's Inn Road London WC1X 8LU
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Contents

SUMMARIES

Page
Summary 1
Sommaire 2
Resumen 2
INTRODUCTION: THE SCOPE AND PURPOSE OF THE REPORT 5
Economic background and world trends in hides, skins and leather 6

CHAPTER 1: ECONOMIC BASIS AND PRE-CONDITIONS

State of animal husbandry and standard of flaying 8
Curing 9
Supply factors: availability of hides 10
Raw materials and services: sources and requirements 10
Local demand for leather and leather goods and future development 12
Export possibilities: a) Neighbouring countries 12
b) Developed nations 12

CHAPTER 2: OUTLINE OF THE MANUFACTURING PROCESS

Pre-tanning 14
Tanning 15
Vegetable tanning 15
Chrome tanning 16
Crust or unfinished leathers 16
Finishing 16
Quality control and market requirements 17
By-products and effluent disposal 18
Possible scale of operations 19
Training 19

CHAPTER 3: DESIGN OF COST MODELS

The level of production and equipment required 21
Plant capacity and production strategy 22
Products and options available 24

CHAPTER 4: ECONOMICS OF PRODUCTION

Capital costs: Land and building costs, prices of available machinery and working capital 26

Operating costs: Price of hides 27

Price of chemicals 27

Cost of labour 28

Transport 28

Power and water supply 28

Prices of products 29

TABLES

1 Capital and operating costs 30

Sources and notes for Table 1 31

2 Tannery buildings and land requirement and costs 32

Sources and notes for Table 2 33

3 Plant requirements and hp demand. Model A 34

4 Plant requirements and hp demand. Model B 35

5 Plant requirements and hp demand. Model C 36

6 Plant requirements and hp demand. Model D 37

7 Rawhide requirements and costs: water consumption and cost 38

8 Chemicals, oils and dyes: requirements and costs 39

9 Electricity requirements and costs 40

10 Manpower requirements and costs 41

APPENDICES

Appendix 1 Tanning of sheepskins and goatskins 42

Table 11 Capital and operating costs related to tanning of skins — all models single shift working 44

Notes on Table 11 45

Appendix 2 Tanning recipes used in the cost models 46

Appendix 3 Forms of tanning other than by chrome and vegetable tanning agents 47

Appendix 4 Notes on some sources of hides and skins other than the main species of domestic animals 48

Appendix 5 Selected Bibliography 49

ACKNOWLEDGEMENTS

Thanks are due to the many firms and individuals in the tanning industry who have provided advice and information in the preparation of this report.

While mention of a company or process and its use in costings does not imply a recommendation of the company or process to the exclusion of others which may also be available, it would be ungrateful not to acknowledge the help of Turner Machinery Ltd for the use of drawings of tannery layout and information on specifications and prices. The Tanning Extract Producers Federation, Booth International Ltd, and members of the staffs of the National Leathersellers' College, the Northampton College of Technology and Leeds University as well as a number of commercial tanneries have been generous in giving their assistance.

The authors wish to thank their colleagues at the Tropical Products Institute for the advice and co-operation which has been readily offered and gratefully accepted.

NOTE

To avoid the constant repetition of the phrase 'hides and skins' the term 'hide' is normally used throughout this report to indicate both. Where it is essential that a distinction be made the full term is used ie 'cattlehides', 'calfskins', 'sheepskins', or 'goatskins'.

Summaries

SUMMARY

Tanning of hides and skins

This report is one of a series designed to help prospective investors in developing countries in assessing the potential of various small-scale industries. Although the cost models are based on actual prices in a South-East Asian country, the physical data supplied should enable users elsewhere to obtain relevant results by applying their own local costs. The Tropical Products Institute is able to help with the preparation of market and feasibility surveys and can provide other technical advice including information on suppliers of tannery equipment.

Cost models have been worked out for four scales of throughput:

A 100 hides a day

B 400 hides a day

C 1 000 hides a day

D 2 000 hides a day

Although models C and D show quite high levels of throughput, the scales have not been selected with the intention of advocating any particular minimum size of tannery. However, they do show that market demand for standard specifications creates problems for the small tannery wishing to compete in export trade. Economies of scale are demonstrated, but some suggestions are made for ameliorating the difficulties of production in the smaller tannery.

Tanning techniques are described in order to assist understanding of the cost models. However, this report is not intended as a manual of tanning and technical advice must be sought as part of a feasibility study. Appendix 5 gives a bibliography for those wishing to explore this aspect in greater depth.

Total capital investment required at each of the four levels of production selected:

Model A – £61 000 which includes £17 000 working capital

Model B – £255 000 which includes £64 000 working capital

Model C – £638 000 which includes £156 000 working capital

Model D – £1 172 000 which includes £308 000 working capital

Tables 1 to 10 show how these figures are built up and provide the physical data which will enable the user applying local costs to make a comparative assessment of varying projects. It will be seen that even at the lowest level of production considered, the investment required is relatively substantial.

The report comments on the marketing and the ability to earn foreign exchange, which influences marketing.

For convenience of presentation the main tables refer to cattlehides, but Appendix 1 and Table 11 provide information necessary for the preliminary survey of a tannery dealing partly or wholly with sheep- or goatskins.

Other Appendices give an account of tanning techniques and raw materials which are not directly relevant to the main body of the report, but which may need to be considered in the course of a feasibility or marketing survey.

SOMMAIRE

Tannage des cuirs et des peaux

Ce rapport fait partie d'une série ayant pour objet d'assister les capitalistes éventuels des pays en cours de développement à évaluer le potentiel de diverses petites industries. Bien que les modèles des tarifs soient basés sur les prix actuels des pays de l'Asie du Sud Ouest, les données physiques fournies devraient permettre les usagers d'ailleurs d'obtenir des résultats pertinents en appliquant leurs propres tarifs locaux. Le Tropical Products Institute peut aider en préparant des enquêtes sur les marchés et les possibilités et peut fournir d'autres conseils techniques comprenant des renseignements sur les fournisseurs d'équipement de tannerie.

Les modèles de tarifs ont été calculés pour un débit sur quatre échelons:

A 100 peaux par jour

B 400 peaux par jour

C 1 000 peaux par jour

D 2 000 peaux par jour.

Bien que les modèles C et D décrivent des débits élevés, les échelons n'ont pas été choisis afin de préconiser une taille particulière de tannerie. Ils montrent cependant que les demandes du marché pour des spécifications standard causent des problèmes au petit tanneur espérant faire de la concurrence dans le commerce de l'exportation. On démontre l'économie des échelons, mais on fait quelques suggestions pouvant améliorer les difficultés de production des petites tanneries.

On décrit les techniques de tannage afin de simplifier la compréhension des modèles de tarifs. Ce rapport n'a cependant pas l'intention d'être un livret de tannage et des conseils techniques devraient être cherchés lors d'une étude de possibilités. Dans l'Appendice 5, on donne une bibliographie pour ceux qui voudraient explorer ce domaine plus profondément.

Placement nécessaire de capitaux à chacun des quatre échelons de production choisis:

Modèle A – £61 000 comprenant £17 000 de capital opérationnel

Modèle B – £255 000 comprenant £64 000 de capital opérationnel

Modèle C – £638 000 comprenant £156 000 de capital opérationnel

Modèle D – £1 172 000 comprenant £308 000 de capital opérationnel

Les tables I à 10 indiquent comment ces chiffres ont été obtenus et fournissent les données qui permettront à l'utilisateur se servant de tarifs locaux de faire une évaluation comparative des différents projets. On se rendra compte que même au plus petit échelon de production considéré, les placements nécessaires sont assez importants.

Le rapport commente sur le marketing et la possibilité gagner des devises étrangères qui ont de l'effet sur le marché.

Pour la simplicité de présentation, les tables principales se rapportent aux peaux de bovins, mais l'Appendice I et la table 11 donnent les renseignements nécessaires pour l'évaluation préliminaires d'une tannerie travaillant en partie ou uniquement avec des peaux de moutons ou de chèvres.

Les autres Appendices parlent des techniques de tannage et des matières premières qui ne se rapportent pas directement à la partie principale du rapport mais qui seront peut-être à considérer au cours d'une évaluation de possibilités et de marketing.

RESUMEN

Curtido de cueros y pieles

Este informe es parte de una serie realizada para ayudar a posibles inversores en países en vías de desarrollo en el análisis del potencial de diversas industrias a pequeña escala. Aunque los modelos de coste se basan en precios reales referidos a un país del Sudeste Asiático, la información física ofrecida peude asesorar a los usuarios en otras partes sobre la obtención de resultados específicos aplicando sus propios costes locales. El Instituto de Productos Tropicales está capacitado para asesorar por medio de análisis de mercados y viabilidades, pudiendo ofrecer otros asesoramientos técnicos incluyendo información sobre abastecedores de equipos de curtido.

Los modelos de coste han sido calculados sobre cuatro escalas de cantidad invertida:

A 100 cueros al día

B 400 cueros al día

C 1.000 cueros al día

D 2.000 cueros al día.

Si bien los modelos C y D indican niveles elevados de cantidad invertida, estas escalas no han sido seleccionadas con la intención de recomendar un tamaño mínimo de curtiduría. Sin embargo, las mismas demuestran que la demanda del mercado especificaciones standard crea problemas para la curtiduría a pequeña escala para competir en la emportación. Se han probado economías de escala, pero se facilitan sugerencias para mejorar las dificultades de producción de las curtidurías pequeñas.

Se describen técnicas de curtido con objeto de ayudar en la comprensión de los modelos de coste. No obstante, no es el propósito de este informe el servir de manual de curtidos, debiendo plantearse el asesoramiento técnico como parte de un estudio de viabilidad. El Apéndice 5 ofrece una bibliografía para los que deseen explorar este aspecto con más profundidad.

La inversión de capital total que se necesita en cada uno de los cuatro niveles de producción seleccionados es la siguiente:

Modelo A — £61.000 — incluídas £17.000 de capital de explotación

Modelo B — £255.000 — incluídas £64.000 de capital de explotación

Modelo C — £638.000 — incluídas £156.000 de capital de explotación

Modelo D — £1.172.000 — incluídas £308.000 de capital de explotación.

En las tablas I a la 10 se indican las composiciones de estas cifras y se facilita información física que permitirá al usuario aplicar costes locales para valorar comparativamente proyectos diversos. Es de destacar que incluso a un nivel mínimo de producción la inversión necesaria es considerable.

Se comenta en el informe la comercialización y la capacidad de obtención de divisas, con su influencia en la comercialización.

Por conveniencia en la presentación, las tablas principales se refieren a pieles de ganado vacuno, aunque en el Apéndice 1 y Tabla 11 se facilitan datos necesarios para realizar un estudio preliminar de curtidos utilizando piel de oveja o cabra, bien parcialmente o en su totalidad.

En otros Apéndices se facilitan técnicas de curtido y materias primas que si bien no se relacionan directamente con el sujeto principal de este informe, pueden ser necesarias en el transcurso de los estudios sobre viabilidad y comercialización.

Introduction

THE SCOPE AND PURPOSE OF THE REPORT

This report is designed as an investment guide for individuals and organisations considering the establishment of a tanning enterprise in a developing country. The raw material requirements and economic pre-conditions are discussed in Chapter 1. Chapter 2 outlines the manufacturing processes and suggests possible scales of operation. In Chapter 3 the design of the cost models is developed and Chapter 4 covers some economic aspects of production.

Because of the very wide range of raw materials which are converted into leather, it has not been possible to deal with every type of tanning. Furskins, which account for about 30 % by value of international trade in hides and skins, are excluded on the grounds that their production is very largely confined to temperate and sub-arctic regions of the developed world. Reptile and game hides and skins, although in the main produced by developing countries, are also excluded because of their specialised nature. They are discussed briefly in Appendix 4 together with other sources of raw material for leather such as pigskins. In total, all these hides and skins represent a further 6 % of world trade. This report therefore is of direct relevance to a more or less homogeneous grouping made up of cattlehides, calfskins, sheepskins and goatskins, which represent the bulk of world production and trade. The cost models, which have been related to factor costs in a country in SE Asia, have been worked out using cattlehides alone for the sake of simplicity, but Appendix 1 carries information necessary for converting the cost models for partial or complete application to skins.

By expressing data in physical as well as financial terms it is hoped that insertion of local cost factors into the models will be made easy. A wide range of levels of production is covered, in order to indicate economies of scale that may be expected. Because of this there are wide gaps in size between the models and, in view of the discontinuous nature of the capital investment required, it must not be assumed that units of intermediate scale will give exactly intermediate results. By use of the tables and relevant appendices however, and by inserting local factor costs, it should be possible to make a preliminary evaluation of any scale of plant appropriate to the available raw materials or the existing market.

Further assistance in the preparation of feasibility studies or in market research can be given by the Tropical Products Institute, which can also supply technical advice after an investment decision has been made. Addresses of machinery makers, technical services and trade organisations can also be supplied.

It is emphasised that this report is not intended as a production manual. The tanning process has been described only sufficiently to clarify its costing aspects and many important and widely used techniques are not discussed. Expert technical supervision of any new undertaking will certainly be required and, in the absence of trained personnel, this may emerge as an additional charge when a feasibility study is carried out.

ECONOMIC BACKGROUND AND WORLD TRENDS IN HIDES, SKINS AND LEATHER

In the developed market-economy countries, growth in demand for leather for footwear during the last decade has been slow, and its use for footwear at least is likely to grow only with population. There has, it is true, been a recent upsurge in the consumption of leather for clothing but the continuance of this trend must depend upon the dictates of fashion.

Synthetic substitutes have made considerable inroads into traditional markets for leather since the Second World War. This has been most marked in the case of heavy leathers for industrial use, where almost complete substitution has taken place. Shoe soles also, traditionally the chief outlet for heavy leathers, are now very commonly made of synthetic materials. Less than 10 % of shoes manufactured in the UK, for example, have leather soles, although in Western Europe generally the corresponding figure is between 20 and 30 %.

In the USSR and Eastern Europe a similar situation exists, although, until 1967, the use of heavy leather for shoe soles was protected by regulations so that synthetics have not yet captured the share of the market that they hold in the West.

Although in some lower income countries of the developed world leather consumption for footwear is still rising with real incomes, it has been found in high income countries that consumption stabilises at between two and three pairs per year *per caput*, so that future demand is expected to rise only with population increase.

High income countries still have considerable net requirements for cattlehides and calfskins but, since their domestic production is rising faster than demand, these requirements are expected to decline after 1975 and to disappear altogether by 1985. If present trends in leather clothing continue however, the outlook for sheep and goatskins, which in the main supply the fashion market, is considerably more hopeful, since net demand in high income countries is likely to expand until about 1985.

Despite the somewhat discouraging market for the output of less developed countries in high income areas, there is still scope for the improvement of their foreign exchange earnings. Although it may no longer be true to say that the majority of hides and skins produced in developing countries are exported in the cured state, before any tanning operations have taken place, there is still a very substantial trade in raw hides. Clearly, by carrying out some form of processing, the gross value of exports must be increased. The early stages of tanning give rise to a considerable quantity of effluent, which is an increasing problem in the urban areas in which tanneries tend to be sited, particularly in the densely populated countries of Western Europe. There is, therefore, some inducement for tanners in these countries to accept partly processed hides for finishing and this could match well with a situation in which, because of lower population density, effluent disposal is less difficult. A further advantage of this approach is that, as we shall see, the early stages of tanning are the least demanding in both capital and technology. They are therefore suited, as an introduction to a very complex craft, to a country which has little tradition of leather processing.

Within the developing countries themselves, given an increase in real incomes and urbanisation, there is almost certain to be a substantial rise in the demand for footwear. Such a demand could easily be met from existing livestock resources. At present, developing countries own 60 % of the world's cattle but produce only 40 % of its cattlehides and calfskins. This is because of low slaughter rates as well as wasted hides and skins. In the case of sheep, developing countries own 38 % of the total and produce 30 % of skins. With goats the position is quite different – 83 % ownership and 85 % production. This is probably because in high income countries goats are kept primarily for milk production and have a very low offtake rate.

In any developing country the domestic market for finished leather and leather goods is likely to be of increasing importance. Opportunities for the setting up of associated light industries may arise, leading not only to increased employment opportunities but also to the possibility of exporting a wider range of products to both developed and developing countries.

Chapter 1

Economic basis and pre-conditions

STATE OF ANIMAL HUSBANDRY AND STANDARD OF FLAYING

Because hides and skins are a by-product of the meat, milk or wool industries and rarely represent even under optimum conditions more than 5–10 % of the value of a dead animal, they are treated in many developing countries as only of minor importance, neither the farmer nor the slaughterer giving them more than cursory attention. Livestock are subject to insect attack and to damage by thorns, barbed wire, the horns of other animals, and by branding, very often in the most valuable parts of the hide. Even supposing that the animal reaches slaughter weight in prime condition, the opportunities for reducing the value of the hide are manifold. The proportion of hides which never reach tanneries can only be a matter of conjecture, and may vary greatly from country to country, but the wide variation in quality and hence prices of hides coming on to the market is a matter of record.

Faults in the hide caused either during the life of the animal or in the slaughtering and curing processes cannot be remedied by the tannery. The first consideration in a tannery enterprise must therefore be the state of the livestock industry. Domestic livestock are not usually kept primarily for the value of their hides. Apart from agricultural reasons of meat, milk or wool production, pasture improvement and soil conservation, they may, particularly in developing countries, be kept for draft or pack use, as providers of manure for fuel, and as an indicator of wealth and social status. The purpose for which an animal is kept is likely to affect the quality of its hide, irrespective of slaughtering conditions. Cattle used for milk production and slaughtered at a mature age will have thinner hides than those raised for beef and slaughtered comparatively early. Similarly, sheep bred for long wool have thinner skins than those kept primarily for meat.

The environment is also important, in that grazing in scrub and rough pastures will give rise to scratches and cuts which appear as flaws in the finished leather. Ticks, warble flies, and certain diseases may also leave ineradicable marks in the hide. Amongst cattle the practice of dehorning would remove a cause of damage, and the discontinuation of branding would assist in preventing down-grading of hides.

When slaughtering takes place, it is helpful if animals can be kept for 24 hours beforehand in quiet conditions with ready access to water and a minimum of food. This counsel of perfection is all too often impossible or, where possible, ignored. If, however, it can be arranged that animals come to slaughter neither fatigued nor overheated, this assists satisfactory drainage of blood from the carcass leading to cleaner flaying and better keeping qualities both of hide and meat. Conditions should be clean and facilities be available, however simple, for hoisting the carcass for flaying without the necessity for dragging it across rough ground with consequent bruising and abrasion. For religious reasons, in Mohammedan and Jewish cultures, a type of slaughtering cut is used which reduces the value of the hide, but in all cases the cut should be straight and clean, and the carcass hoisted to bleed in order to minimise contamination.

Flaying, that is the removal of the hide from the carcass, should begin as soon as bleeding stops. This work is highly skilled and under the best conditions virtually no damage is done. On the other hand in some developing countries where unsuitable methods and equipment are in use, it is almost unknown for an undamaged hide to be produced. The widespread use of pointed, two-edged knives for flaying, as well as slaughter, has been cited as the main reason for damage by cuts, scores and gouges. Other common reasons for down grading are inadequate bleeding, as retention of blood in the capillaries leads to rapid bacterial action and marking of the hide along the lines of blood vessels; bruising caused by rough handling, which again causes accumulation of blood in certain areas with consequent accelerated putrefaction; blood or dung on the surface of the hide; abrasions caused by dragging the animal over rough ground, and opening up the carcass along the wrong ripping lines, giving a badly shaped hide which will not give the maximum yield of finished leather.

Clearly, in a large abattoir with equipment for mechanical handling and flaying, it will be more easily possible to produce a consistently high quality of hide than under rural conditions, with inadequate equipment and facilities and unskilled labour. A barrier to many schemes for improvement of standards is the all too common marketing process in which hides pass, unsorted, through the hands of a number of dealers before sufficient quantities are accumulated for any worthwhile grading to take place. This implies that the initial purchase from the slaughterer is likely to be at a very low price, both to allow for middlemen's profits and to compensate for the poor quality and low selling price of the product.

Until there is some system of grading at the point of slaughter, making it possible for both the farmer and the slaughterer to receive a premium payment for quality hides, there can be little hope for improvement. It is probably necessary for legislation to be enforced, together with the introduction of a programme of education and instruction, if rural slaughtering techniques are to be integrated with a modern tanning industry. The alternative is the establishment of modern abattoirs and this is, indeed, being done in many areas. Nevertheless, for many years to come, a very large proportion of slaughtering in developing countries is certain to take place outside such establishments.

CURING

Unless it is possible to begin tanning within 24 hours of flaying, which would only occur in the proximity of large abattoirs, some form of curing must be carried out to prevent putrefaction. In hot, dry conditions, air-drying can be employed to reduce the hide moisture content to about 12 %, at which level bacterial action is halted. At its simplest, air-drying consists merely of spreading or pegging out the 'green' (raw and untreated) hide on the ground. Poor ventilation and contamination of the ground side, together with overheating of the exposed surface in direct sunlight, give a product of poor quality. Successive improvements can be made by hanging the hide over poles or ropes, stretching it on lines or frames and protecting it from direct sunlight and rain.

If salt is available cheaply, the hide may be spread, flesh side up, liberally sprinkled with salt (between 25 and 50 % of the green hide weight being required) and covered with a second hide, the process being repeated as a stack is built up. In modern abattoirs, hides are sometimes circulated in a tank of brine, which has the advantage of giving a cure more rapidly than with the use of dry salt. Once the salt has penetrated the stacked hides, they may be either transported in the wet condition or dried first.

Dried hides are liable to damage in packing and transit because they are brittle. They are also more prone to insect and vermin damage and, in the unsalted state, to putrefaction if they become wet. On the other hand they are very much lighter than in the wet condition, with consequent reductions in handling and transport costs.

At every stage, from slaughter until the cured hide reaches the tannery, it is possible by carelessness or ignorance to reduce its value to nothing. Since the production of first class hides calls for considerable skill and effort, and since they are essentially a by-product, it is perhaps not surprising that all too often such a reduction is achieved. There then arises the situation in which the producer, discouraged by the low price of hides, and the purchaser, by the difficulty of marketing an inferior product, combine to give a downward spiral of quality and return. In order to break this spiral it is necessary for the potential rewards to be understood and, once understood, to be available. Recorded prices in one East African country, for example, show that comparing the top grade with the lowest, among cattlehides the price may be three and a half, with sheepskins eight and with goatskins eleven times as great. This is confirmed by comparable Indian figures from five main centres. This price differential is carried forward with finished leathers; imports into France, for example, showing that among comparable leathers for similar end-uses, those from the best sources have average unit values ten times greater than those at the bottom end of the market.

SUPPLY FACTORS: AVAILABILITY OF HIDES

Tanneries prefer not to carry large stocks of hides, since this may represent considerable tied-up capital, but supply factors may make this course necessary. It must therefore be ascertained whether any fluctuations in the supply of hides, sufficient to affect the running of the tannery, may be anticipated. This will enable an estimate to be made of the minimum stock which must be carried and whether this needs to be increased at certain times of the year.

Because of the by-product nature of hides, supplies are independent of the demands of tanneries and the prices which they may be prepared to pay. The level of output of hides may depend on shifts in demand, whether locally or worldwide for meat, dairy produce and wool. Supplies are not easy to predict because there is a time lag between growth in demand for these products and any anticipated change in slaughtering levels, during which time herds or flocks are being built up or run down.

Changes in government policies allied to changes in systems of subsidies and guaranteed prices may lead to a temporary acceleration in the slaughtering off-take of a class of stock, with an inevitable decline in the longer term. Apart from deliberate changes in policy, other even less predictable factors may affect supplies. Drought, flood, fire, frost, or disease may lead locally to widespread slaughterings and a subsequent period of inactivity while stocks are being replaced.

Other factors to be taken into account are seasonal variations associated with well defined wet and dry seasons and religious and national fasts and feasts. In the longer term, social and economic trends, as for example the decline of nomadic husbandry, may affect offtake rates as well as hide quality.

Raw materials and services: sources and requirements

Hides are the main raw material cost element of a tannery, representing more than half the annual operating costs. The quantities in which hides are likely to become available, and the continuity and probable trend of supplies, will largely determine the scale of investment that can be considered. Although in many developing countries there are large municipal abattoirs and even large packing stations which are reliable sources of good quality hides, it will probably be found that the major proportion of slaughterings take place on a small scale and are scattered over a very wide area. This gives rise to obvious problems of collection and transportation. If collection is through agents and middlemen the price paid to the farmer or butcher may be unrealistically low, discouraging improvements in quality, and if the tannery is to undertake collection the cost of transport and associated organisational problems may be beyond its scope. If therefore, a tannery at more than the lowest level of production is contemplated, in the absence of major sources of supply of hides such as municipal abattoirs, there is a strong case to be made for an official programme of instruction for the farming community in the value of raw hides and their proper handling. The setting up of co-operatives or government sponsored collection agencies to handle the output of small producers is a further possibility.

The two classes of tanning materials in most common use are vegetable tannins and basic chrome salts ('tan'). Vegetable tannins occur in almost all plants, but rarely in sufficient quantity to make collection commercially worthwhile. Among the more usual sources of vegetable tannins are the bark of Quebracho, a South American tree; mimosa (wattle) bark from a number of species of *Acacia* found in Australia and Africa and myrobalans, the fruit of an Indian tree. These are exported widely as concentrated extracts, but there may be advantages for a developing country in investigating indigenous materials with the object of establishing an ancillary industry.

Chrome tanning will almost certainly depend upon the import of prepared chemicals. Although chromium ores are not uncommon, the production of tanning agents is carried out more and more by specialist firms able to make a uniform product. In the absence of the technology required for the manufacture of chrome tanning liquors and powders, the probability is that even if chrome ores are available, tanning agents will be imported. If the tannery is to be export orientated, there is a considerable initial advantage in importing both vegetable and chrome tanning agents, in that finishing plants in the developed world are likely to have more confidence in the end-product than in one made with an unfamiliar tanning material.

Of the other chemicals required, lime (calcium hydroxide) is needed in large quantities, as well as sodium sulphide, and probably ammonium chloride (or sulphate), sodium chloride, sulphuric acid, sodium bicarbonate, various enzymatic bates, oils, fats and dyes depending upon the process and degree of finishing decided upon. At least some of these may be available locally, either immediately, or in the future as sources are developed.

The tanning process demands a very large supply of water. Estimates vary, but a widely accepted figure is 50 times the weight of rawhide processed. Soft water is preferred. The supply must be constant throughout the year and the bulk of demand occurs in the early stages of the process so that little economy is achieved by part processing.

For all but the crudest forms of tanning, a three phase electricity supply is required and where finishing is undertaken demand is likely to rise very steeply.

Effluent disposal has become a considerable problem to tanneries, particularly in the developed world where increasing pressure is being put upon industry to minimise its effect upon the environment. More than 70 % of the polluting substances in tannery effluent arise in the pre-tanning stage so that there is no way for the tannery carrying out initial processing to avoid the problem. Even where there is no immediate pressure from local legislation for a new tannery to make provision for effluent purification and disposal, it might be considered prudent at least to set aside sufficient land for this purpose with an eye to the future. However, conditions vary greatly and a decision on this point can only be made in the light of local knowledge.

Labour requirements are comparatively heavy but in general a high degree of skill is not required. Certain finishing operations require considerable manual dexterity but not a great deal of physical strength and are suitable for women in areas where there is a tradition of women going to work. Considerable demands are placed upon management and a high degree of technical 'know-how' is required, in that hides vary from batch to batch in condition and quality, and processing will have to be adjusted frequently if a consistent standard of output is to be achieved.

LOCAL DEMAND FOR LEATHER AND LEATHER GOODS AND FUTURE DEVELOPMENT

Information on internal consumption of leather and leather products in developing countries is scanty but, in the absence of an existing industry, some estimates of local demand and price level may be possible based on imports of footwear, if statistics are available separately from those on clothing. In many countries there is some production of articles for the tourist trade at handicrafts level, which might be capable of expansion, but it is very probable that in the establishment of a tanning industry production will outstrip the capacity of the domestic market and that export outlets will take the bulk of the output. In time, however, the existence of a tanning industry is likely to encourage the establishment of industries to satisfy local demand for finished goods.

EXPORT POSSIBILITIES

(a) Neighbouring countries

Trade between developing countries in leather and leather goods is, with the exception of India as a major world wide exporter, almost non-existent. Trade flows are still mainly of raw materials from the less developed to the developed countries, with finished goods moving in the opposite direction but, with the developing countries representing a major future growth area for the sale of leather goods, large potential markets certainly exist. It is known that leather and hides are imported from advanced countries into Malaysia and the Philippines, where footwear industries were established first. This pattern of development may exist elsewhere.

(b) Developed nations

The hides, skins and leather industries of developing countries find their main customer in the developed world, only about 3 % of their exports being to other developing countries. There is, at present, a clear trend away from trade in raw hides towards partly finished or finished leathers. This has been carried to its logical conclusion by countries such as India and Argentina which have introduced legislation raising barriers against the export of raw hides, on the grounds that their processing provides increased employment opportunities, the possibility of the development of ancillary industries and increased foreign exchange earnings.

In assessing the foreign exchange that may be earned, or saved, by taking leather processing to any particular stage, it must be remembered that although gross earnings increase progressively, net foreign exchange earnings will be determined by the degree to which materials, capital, or expertise have to be imported.

In spite of the fact that certain environmental and labour cost advantages accrue to the country which accepts its hides as semi-finished leather, the clear preferences of the developed nations are shown by the fact that in most countries raw hides are admitted duty free; rough tanned leather is subject to a 10 % duty and finished leather and leather goods bear duties of from 20 to 30 %. In addition, the relative standard of technology in the developed, as opposed to the developing, nations encourages the finishing and making up of leather goods in the former. Ease of marketing is consistent with this situation since the customer in this trade requires very rapid service in view of the sudden and radical changes in fashion which are not uncommon. Delays due to long lines of communication make such service difficult, if not impossible, to achieve. Also, unless he has confidence in the ability of the finisher in a developing country, the potential leather importer may see his lack of control over processing as an obstacle to the growth of trade.

It seems probable, therefore, that from the point of view of a developing country moving into leather processing, export opportunities other than raw hides may be restricted initially to rough tanned leather for finishing elsewhere. Finished leathers might be produced in increasing quantities to meet the needs of domestic manufacturing industries supplying the internal market for footwear and other leather products.

Chapter 2

Outline of the manufacturing process

PRE-TANNING

Since it will normally be necessary to store a reserve supply of hides, a cool, dry, insect- and vermin-free reception and storage area should ideally be available. When hides are moved from this area into the limeyard or beamhouse, the first operation in all cases is a soaking in water to restore moisture lost since flaying and to remove salt, blood and dirt. Disinfectants may be added to prevent putrefaction, but it is important to ensure that they have no tanning action. Sodium hypochlorite is recommended for this purpose. Soaking can be speeded by agitation of the soaking vats, or by use of rotating drums.

The hides are next placed in a mixture of lime, water and sodium sulphide, the effect of which is to loosen or remove the hair depending on the period of immersion and the strength of the solution. If hair remains on the hide it can be removed by scraping with a hand knife or by passing between the rollers of a dehairing machine, in which blunt scraping knives arranged in a double helix on a cylinder spread the hide flat and pull the hair from it. Special techniques are used in the case of woolled sheepskins, involving painting the flesh surface with a mixture of lime and sodium sulphide, after which the loosened wool is removed by hand.

Unless 'green fleshing' (the machine cleaning of the flesh side of the hide immediately after flaying) has been carried out, it will now be necessary to remove any flesh, connective tissue and fat which still adhere to the hide. This can be done with a special two-handed knife, or by a fleshing machine, similar in action to a dehairing machine but with sharp edged knives in place of blunt scrapers.

For various purposes it may be necessary to split the full original thickness of a hide or skin. The specific description of a split is related to the side of the skin to which it was nearest in the original, the layer removed nearest to the flesh or inner side being referred to as a flesh split, and that nearest to the grain or hair side being called a grain split. With thick hides a middle split may also be obtained. In the case of sheepskins, flesh splits are used in chamois leather production, while those from cattlehides may be chrome tanned and used for industrial gloves or certain forms of clothing. Splitting of hides may be carried out after fleshing since at this stage lime induced swelling or 'plumping' assists the operation, but it may also be done after tanning. In either case splitting is achieved by feeding the hide between rollers against a band knife. Accurate setting and first class maintenance of this unit is essential as it must work to relatively fine tolerances. Where especially careful cleaning of the grain is required this is carried out by scraping with a blunt hand knife, or by use of a 'scudding' machine similar in design to the dehairer.

Because lime would interfere with subsequent tanning operations it is now necessary to remove it from the hides, the degree of deliming being determined by the type of tanning to be carried out. Sometimes weak organic acids are used for this process, such as boric acid, but ammonium chloride or ammonium sulphate are satisfactory in normal commercial practice. There is a danger with over-rapid deliming that the hide surface may become hardened and less easily penetrated by tanning agents. Where 'bating', or the use of certain enzymes to modify the fibre structure to give more supple and elastic leather is to follow, deliming is carried out to a pH of about 8. The pH value is a measure of the acidity or alkalinity of a solution expressed as a scale of numbers ranging from 0 (extreme acidity) to 14 (high alkalinity). A neutral solution has the pH value 7. Many vegetable tan liquors are themselves highly acid so that in vegetable tannages it is not necessary to reduce the pH of the delimed hide below 7 or 8, but for chrome tannages it is normal to 'pickle' hides (after bating where this is carried out) in strong mineral acids such as sulphuric acid, and salt, reducing the pH to 2.5 – 3.0 before tanning.

The pre-tanning process is broadly similar for all types of hides and skins and for all tannages. Using traditional methods of soaking pits or vats, even when rockers or circulators are used it will occupy one or two weeks. In a modern tannery, using rotating drums, and provided that it has not been necessary to soak back dried hides, pre-tanning can be carried out in two working days.

If pickling is carried out, hides may be stored in the pickled condition, and may be transported elsewhere for tanning. There is considerable international trade in pickled sheepskins and goatskins but it is thought that this trade is likely to decline as the value added at this stage is not attractive to the exporting nation compared with wet blue leather. If hides are not pickled, they must be tanned without delay since they are now susceptible to bacterial action.

TANNING

Tanning is the process which converts protein in hides into a stable, non-putrefying substance and it is carried out by bringing the hides into contact with tanning liquors in some type of vat, or in modern tanneries, drum. Of the two most widely used tannages, vegetable tanning gives a dense, solid leather, brown in colour, traditionally used for shoe soles, upholstery, belts and straps. Chrome tanning gives a softer leather, pale blue-green in colour and used for shoe uppers and clothing. The two types of tannage can be combined to produce leathers with intermediate characteristics.

VEGETABLE TANNING

Traditionally vegetable tanning was carried out by immersing hides in a pit of water, with layers of tannin-bearing bark or wood sandwiched between them. Tanning by this method could take up to 18 months in the case of heavy leathers. The availability of concentrated vegetable tanning extracts has made tanning a matter of weeks rather than months, where the necessary equipment and technology are available, and recent developments have reduced the period even further. For full tanning of industrial leathers suspension of hides in pits of increasingly strong tanning liquor is still employed, but accelerated treatment in drums is becoming an established technique. These drums, which can usually be locally constructed, are of large diameter and fitted with internal projections which lift the hides as the drum rotates, until the increasing angle causes them to slide off and fall back to the bottom of the drum. The vigour of this action is increased by the use of a larger load of hides or water, faster rotation, or greater diameter of drum. It is possible to construct a drum from which the liquid contents can be withdrawn, while retaining the hides, so that a number of processes may be carried out, as for example liming, deliming, bating, pickling and tanning, without removing the hides.

The market for which the leather is intended will determine the fullness of the tan. Where the intention is to export rough tanned leathers the method known as fringe vegetable tanning is particularly suitable. In this method, the tanning material used is often mimosa and the intention is to achieve a rapid uptake, in 24 hours or less, of about 10 % of tan on raw material weight, which may be compared with an uptake of perhaps 40 % in conventional systems. This method of tannage has been advocated as a process which is both economical in tan used and highly flexible where further processing is concerned. It gives a light coloured leather, readily wetted back, easy to handle and sort, and cheap to transport because it does not contain large quantities of either water, or vegetable tannins. This last point means also that if it is wished to strip the tan, as part of further processing in an importing country, there will not be as serious an effluent problem as in conventionally vegetable tanned hides. A considerable amount of recent work on this technique has been carried out in Britain, and the Tropical Products Institute can give advice on sources of information and suppliers of suitable equipment and materials.

CHROME TANNING

It has already been noted that chrome tanning is normally preceded by pickling, after which the hides are drummed in a prepared tanning liquor. Chrome liquor, which is an aqueous mineral tanning liquor containing about 3 % sodium chloride and 33 % basic chromium sulphate, equivalent to 2.5 – 3 % chromic oxide, is employed in the chrome tanning process and may be purchased in prepared form. Tanning is normally complete in 5 to 10 hours and the pH is then raised to about 4.5 by the addition of a weak alkali such as sodium bicarbonate.

CRUST OR UNFINISHED LEATHERS

When tanning is sufficiently completed it is feasible to dry both vegetable and chrome leathers and market them in this form as 'crust' leathers. It is usual to 'fat liquor' (impregnate with emulsified oils) chrome tanned leather at this stage to avoid difficulties which have been experienced in rewetting, and there is considerable trade in the wet blue form. Crusts may be partly finished in that chrome crusts may be washed and fat-liquored and vegetable crusts bleached or oiled depending upon the requirements of the market.

Excess moisture may be removed by 'sammying' in a machine similar in principle to the domestic mangle. 'Setting out', a process designed to stretch the hide to the optimum area, is achieved by the use of a modified dehairing machine or by working over with a blunt blade of brass or plastic.

FINISHING

If leather is not to be marketed at this stage it may undergo a number of further processes. Typically, these would include most of the following, although not necessarily in the order given.

The leather is dried, either stretched on a frame or pasted to a glass sheet and passed through a stream of warm air, or in a more recent development, under vacuum. It may be stacked and 'rested' to allow equalisation of the moisture content and then worked ('staked') either by hand or machine to make it more pliable. It may be shaved or split to obtain the desired thickness. Dyeing, by brushing, spraying, drumming or dipping, may be carried out at some stage of the processing and the surface may be treated in a wide variety of ways, for example by the embossing of an artificial grain (sometimes useful to mask defects) or buffing to produce suede, and it may be pressed, glazed and seasoned to improve the appearance. Polyurethane or other polymer coatings may be applied. These will contain pigments if particular colour effects are required.

QUALITY CONTROL AND MARKET REQUIREMENTS

The tanner, because he is dealing with a raw material of a heterogeneous nature, is often faced with considerable problems in attempting to manufacture to a specification. Sorting of hides must be carried out at each stage of manufacture, and because there are no accepted international standards it is essential that the requirements of potential markets be explored fully.

The International Union of Leather Chemists' Societies (IULCS) has, for many years, maintained both leather analysis and physical testing commissions with the object of standardising methods used. Each of the national societies which collectively form IULCS frequently reviews physical and chemical tests for leather quality controls and can provide details of its latest recommendations.

The British Standards Institution has provided specifications for many kinds of leather. They are conveniently grouped together in a section of the *Bibliography of Standard Methods* published by the Society for Analytical Chemistry (UK), details of which are given in Appendix 5. Many other countries have their own well-entrenched systems of specification and grading, and a technical committee of the International Organisation for Standardisation has been set up to attempt to reconcile these and give guidance in the future to national standards organisations.

Among developing nations, India is outstanding in the field of tanning both in technology and the pioneering of export outlets. It is instructive therefore to examine the grading system for wet blue chrome leather prepared by the Indian Standards Institute (ISI) for cow hides.

It is true that India is unusual in that the bulk of its cattlehides are not from slaughtered animals, but from those which die from natural causes. The proportion of waste and rejection before the hides enter trade is not known but of those purchased by tanneries, rejections at each stage of processing are as follows.

Raw sorting up to 10 %

Liming sorting up to 30 %

Pickling sorting up to 10 %

The average rate of rejection is more than 40 %

For the grading of the wet blue chrome leathers the ISI suggests the following system.

Grade I Firsts

The hide should have good grain with well filled flanks and up to two small defects (eg warbles or healed scratches). The hide should be completely free from flay cuts and drawn grain.

Grade II Seconds

The hides should have good grain with filled flanks and up to 4 defects and not more than 25 % drawn grain.

Grade III Thirds

The hides will have a good grain with up to 6 defects. Drawn grain and loose substance should be not more than 50 %.

Grade IV Rejections

Any hides below the standard of Grade III.

Typical gradings in India would yield 25 % Firsts, 40 % Seconds, 30 % Thirds, and 5 % Rejections.

The term 'rejections' is perhaps misleading since this grading does not necessarily preclude export. Certain markets will accept poor quality leathers, but prices tend to be very low.

It is interesting however to observe that, bearing in mind that pre-selection will have taken place before hides enter the tannery, it is entirely probable that less than 50 % of available hides qualify for Grades I to III. That this is the situation in India with its very well established and experienced tanning industry, should highlight the importance of realistic appraisal of quality of raw material and its potential by any prospective exporter.

It should be emphasised that such an exporter will be wise to develop and maintain close relationships with importers in his chosen market. In the establishment of a new tanning industry this may well be one of the most difficult problems, particularly if small- and medium-scale establishments are considered. Where a tannery is not of sufficient size to attract the interest and advice of a reputable importer, it may be that in the absence of government sponsored trade missions, some form of co-operative marketing venture is a possibility. In any event it is fundamental to a feasibility study that market potential be established and advice obtained on appropriate grading procedures.

BY-PRODUCTS AND EFFLUENT DISPOSAL

In large-scale tanneries considerable quantities of tanned and untanned waste arise from trimmings from hides, also dirt and scrapings from the defleshers, shavers, buffers and other cutting or abrasive machinery. Hair can be collected and washed if a market exists, but this will depend upon the quantity and quality of output.

Trimmings and scrapings from hides can be divided into untanned and tanned collagenous waste. Uses for untanned material include the manufacture of artificial casings for sausages, surgical materials, glue, gelatin and animal fodder. Tanned collagenous wastes have fewer end uses but can be a source of nitrogen for fertilizers or used in animal feeds provided they contain no deleterious substances.

This is not to imply that all, or indeed any of these end uses will be available for waste from a new tannery in a developing country. In the initial stages it must be assumed that waste materials will represent a net loss in that their disposal will be an operating cost, but in the longer term their availability may encourage the growth of subsidiary industries to process them.

Even assuming that all useable waste is removed, the remaining effluent will contain a number of undesirable substances and if mains drainage is available it must be determined from the public health authorities in what form the waste will be accepted by the sewerage system. For a tannery in a rural area the problem may be less pressing if land is cheap and sufficient can be written off as a soak-away. If effluent is to enter rivers, legislation may exist to lay down what treatment must be carried out to neutralize harmful substances.

If settling tanks are available, solids can be separated from the effluent and dried to provide a fertilizer in the absence of other end uses. The liquid may then be allowed to enter a lagoon, large enough to retain the effluent from two days production. Aerators placed in the lagoon to bubble oxygen through the effluent would satisfy the biological oxygen demand of the waste liquid and render it acceptable in most sewerage systems, although further purification might be required before release into rivers. This aeration treatment has been shown to be most efficient in the presence of a manganese catalyst.

POSSIBLE SCALE OF OPERATIONS

For a modern, fully mechanised tannery geared to the production of finished medium quality leathers, there is general agreement that the minimum throughput that it is reasonable to consider is of the order of 140 000 cattlehides per annum, taking the average, rather small tropical hide as yielding $2m^2$ of finished leather. This represents 600 hides per day or 75 per hour on single shift working, or about two thirds of the capacity of a modern fleshing machine.

If this is an acceptable level of efficiency, and by the use of simpler, older, reconditioned machinery it may become more so, the limeyard and tanning operations can be geared to this rate without disproportionate expenditure. It is in the finishing department that problems are likely to arise.

Leather is very variable in quality and type, and this may be very marked in a developing country where the range of cattlehides may be from exotic breeds kept for beef production upon the one hand, to the cullings of nomadic herds on the other. In order to provide equipment to finish the resultant wide range of leathers correctly it may be necessary to install machinery which will be grossly under-employed.

For the small- and medium-sized processing unit, therefore, the most acceptable short term policy may be to process all leathers to the crust stage, exporting selections which conform to international standards and processing whatever remains for the domestic market, using one or two cheap standard finishes.

Although upper leathers for footwear would be suitable for this type of final treatment, difficulties would arise if an attempt were made to produce leathers more susceptible to the whims of fashion, such as dyed leathers for clothing. Producers in developing countries, unless they are operating on a very large scale, are unlikely to have access to the sophisticated marketing research which is critically important in this field.

It is necessary to approach a level of production of nearly double this number of 600 hides per day before a reasonably complete range of finishing machines can be fully utilised and all reasonable market demands met. Below 600 hides per day, although production of finished leathers can be carried out, if the object is to seek export outlets, problems may arise because the comparatively small quantities involved may not attract the interest of the most profitable markets.

By the use of appropriate methods there is no technical reason why first class leather could not be produced in small quantities, but for successful export marketing uniform standard selections are required and this demands mechanisation which argues a certain minimum scale of operation. If the object on the other hand is to use local labour and raw materials to advantage, by providing small quantities of leather for making up into tourist souvenirs, then most of the problems disappear, but so do the prospects of major foreign exchange earnings from semi-finished and finished leather.

A possible compromise would be the integration of a number of small rural tanneries within a co-operative marketing structure. Provided that tanning techniques are sufficiently similar for well-graded selections to be marketed as if from a single tannery such a system can be successful, as the producers of crust goatskins around Kano, in Nigeria, have shown.

TRAINING

In the setting up of a new tannery enterprise, it would be fortunate indeed if the necessary skills and experience were readily available locally without the need for further training. Organisations exist in the United Kingdom and other developed countries, which offer training in leather technology and tannery management but, as has been pointed out, the variability of the basic raw material calls for wide experience as well as knowledge if a reasonably uniform product is to be obtained. If, in the early stages of a tanning enterprise, the necessary expert skills are not available locally, they may be obtained from other sources.

On the smaller scale of production, independent provision of such training could become an impossible burden and, if progress is to be made, governmental support by way of training and advisory facilities would be essential. In Britain, as in most developed countries, there are organisations which offer industrial training to students from overseas.

Chapter 3

Design of cost models

THE LEVEL OF PRODUCTION AND EQUIPMENT REQUIRED

To cover all possible types of hides and skins and the options open for their treatment would be beyond the scope of this report. The intention of the cost models is to illuminate the points which must be covered by a feasibility study in a specific case. It has been decided, therefore, for the sake of clarity to confine them to the processing of cattlehides only. Appendix 1 shows how the models may be converted to apply to tanning of skins.

It cannot be emphasised too strongly that conditions and costs vary greatly through space and time and that the cost models must be taken only as a starting point for the full scale feasibility study that should be undertaken before any financial commitment is made.

Factor costs for a country in SE Asia, adjusted to the level prevailing at the end of 1972, have been used because they were available in a very complete form and where assumptions have had to be made this has been indicated in the appropriate table. Although if reworked using factor costs for another country the cost models would certainly be altered in detail, it is expected that the overall pattern would be broadly similar.

Estimates of the minimum level of production that justifies a well equipped modern tannery vary with different raw materials and market conditions. Among the commercial organisations visited during the preparation of this report, there was some agreement that a steady supply of about 600 hides a day would attract potential investors, although economies of scale would favour much larger units. In setting up the cost models four levels of production have been chosen, the middle two of which represent the limits of the range of investment thresholds suggested by these commercial organisations. The other two cost models show the effects on the one hand of very small-scale mechanised production, and on the other of the economies which might be achieved by a relatively large tannery. The degree of mechanisation which is possible at each level of production is indicated.

With tanning and pre-tanning operations, with one or two exceptions, it is not impossibly difficult to build up production steadily, adding another unit as required, but this is certainly not true of the finishing department. In those areas where a tradition of leather working exists there may be craftsmen able to finish leather by established techniques and manufacture products from it. When starting from scratch this is not likely to be so and particularly where export trade is sought, there is no real alternative to mechanisation in finishing, with all its problems of scale.

In the cost models finishing costs have been allowed for to indicate the difficulties that arise at the lower end of the scale range, although some operations have had to be omitted or carried out by hand. The general criterion has been that if a machine will have the throughput to operate at 50 % of its capacity, it should be installed.

The scales of production chosen as illustrative of the problems of tannery construction and operation are as follows:

Model A – 100 hides per day

Model B – 400 hides per day

Model C – 1 000 hides per day

Model D – 2 000 hides per day

All these are in terms of single shift working, so that the output of each unit could be increased without the need for more fixed capital expenditure.

The degree of mechanisation of each unit is detailed in the appropriate tables (Tables 3-6), but in brief it has been assumed that modern techniques will be used wherever justifiable. This does not necessarily imply a capital intensive situation. For example, movement of materials is by hand rather than mechanical means where this will not cause a bottleneck.

In the rawhide store, the tanyard and the tannery there is very little difference in technology at the various levels of production. In Model A splitting is omitted despite the penalty of reduced income as the return from the extra flesh splits is unlikely to justify the capital expenditure involved. Otherwise all operations are carried out in broadly the same manner but with variations in detail such as the hand unloading of raw hides in Model A and the use of mechanical means in the larger units. At the end of the tanning process all wet blue and vegetable fringe leathers should have been made to a good standard within the limitations imposed by raw material quality.

In the finishing department, where it is assumed that only standard mid-brown upper leathers or suedes will be produced, there is a great variation in the technology which it is economically reasonable to apply. Of the eleven operations listed only one can be carried out mechanically in Model A (dyeing, using a drum) and three are not carried out at all as having no acceptable manual equivalent (sammying, pressing and buffing). In Model B four operations are mechanised (sammying, shaving, dyeing and measuring) and only buffing and pressing are omitted. In Models C and D all operations are mechanised.

Thus, in the models (A and B), which are below the output level assumed for profitable mechanised operation, it has not been possible to include all the standard finishing operations which would help to ensure a high quality product. If the intention is to supply finished leather for making up into footwear and leather goods for the domestic market and the tourist trade this may not be a serious handicap. Provided high quality raw material is available an acceptable alternative would be to cut short production at the tannery stage and sell the whole output for finishing, but it would be unrealistic to suppose that no unsaleable rejections would occur.

Since it would appear inevitable that a proportion of output will not be marketable directly in crust or wet blue form, a finishing department should be able to convert this into leathers of adequate quality for, for example, the production of shoes and fancy goods as import substitutes. It has therefore seemed realistic to include a finishing department of some sort, even at the lower levels of production.

PLANT CAPACITY AND PRODUCTION STRATEGY

It is assumed that the daily input of hides will be equally divided between the production of wet blue and fringe vegetable tanned leathers. In practice, a tannery might specialise in one form or the other, or switch production according to market requirements, but for cost model purposes both lines are assumed to run coincidentally. For one reason or another, either to foster a domestic manufacturing industry, or because of marketing problems, half the production of each line is retained for finishing.

A problem in the design of the cost models has been the relatively high throughput of standard tanning equipment available on the market. The same basic range has been used in all the models, additional units being introduced where necessary at each stage, but economies of scale have favoured the higher levels of production.

In the rawhide store the equipment required is simple, consisting of scales and some form of transport for the hides. Platform scales have been suggested for Models B, C and D but a cheaper type of yard-arm scale is considered adequate for Model A. In this case the labour force is relatively large, so that problems caused by peaks and troughs in labour demand for off-loading and handling of raw materials should not be acute and it is assumed that this is done manually with the aid of hand barrows. In the other models it is suggested that one fork-lift truck should be available in Model B and two each in Models C and D. It would be possible by increasing the labour force to do away with these, but at least in C and D (which have a high degree of mechanisation in other departments) this policy would give rise to problems of absorption of labour when not required for handling purposes. At the stage of carrying out a feasibility study the actual supply pattern of raw materials would determine the equipment and manpower required, but it is assumed for present purposes that supplies of hides will be uneven and irregular, with periods of high and low slaughter rates necessitating periodic stockpiling and facilities for efficient handling. Imported chemicals will also be delivered in large quantities at infrequent intervals. Because of this irregular flow, it has not been considered worthwhile for any of the model tanneries to run their own commercial transport. With all transport hired, a rapid turn-round in loading and unloading will reduce charges, justifying the use of mechanised handling in Models B, C and D.

In the limeyard, all models have been allowed a fleshing machine. In the case of Model A this may be questioned since throughput is well below the 50% level used elsewhere as the normal criterion for installation. Why, it might be asked, has a fleshing machine been allowed for Model A when a splitting machine has not? The rationale behind this decision is that it is vital when aiming for the international market, not to downgrade the leather irreversibly by tanning faults. If fleshing is not well carried out subsequent tanning may fix unwanted flesh or connective tissue, or mechanical damage may be caused by unskilful hand operations. Bearing in mind that in a developing country there may be no tradition of craftsmanship in leather, the fleshing machine which, subject to the development of adequate operating skills, will provide a standard, well finished article has been thought desirable. The splitting process on the other hand can be carried out by the purchaser at a later stage, after tanning, and, since the machine calls for some skill to maintain and operate, its omission at this level of production is thought prudent. The concomitant of this, however, is that the gross production of tannery A will obtain a relatively lower return than that of the other models because, firstly, in the absence of splits a smaller quantity will be available for sale and, secondly, because the leather produced will be less well finished.

In the case of drums used in the limeyard, as throughout the tannery, by making use of comparatively small sizes the discontinuous nature of the fixed capital investment in this respect has been overcome. Drums are in the same size range in all models. In conducting a feasibility study it might well be found preferable to consider using larger drums or a mixture of sizes at some stages and levels of production, but since the effect of this on capital invested or power requirement is not great, the use of uniform sizes has been convenient for the purpose of this report.

The indicated through-put of the fleshing machine specified is about 100 hides per hour of the size of hide estimated. Thus with Model B it will only be employed at 50% of capacity and with Model A 12.5%. Although its use in Model A may be justified, there is a strong case to be made for the purchase of second-hand or obsolete equipment which might be adequate at this level of output, or for the investigation of the possibility of shared facilities in a co-operative venture.

The splitting machine is of approximately the same capacity as the fleshing machine. In Model C, therefore, capacity is 2 x 100 per hour compared with a through-put of 125 hides per hour and in Model D, 3 x 100 for 250 hides per hour. This is an illustration of the problems of investment when only high capacity production units are available.

Hides entering the finishing department have been estimated as half the output of the tannery. In fact, certain facilities, such as the sammying machines and the drier, will be used for some unfinished leathers, but generally speaking hourly rates are:

Model A –	6.25 hides per hour
Model B –	25.00 hides per hour
Model C –	62.50 hides per hour
Model D –	125.00 hides per hour

Model A is effectively outside the scope of mechanisation.

Although the models have been set up and costed on the artificial assumption that through-put will be evenly divided between wet blue chrome and fringe vegetable tanning, with half the tanned goods going on to be finished, the tannery would be able to convert easily to 100% wet blue or pickle production if circumstances demanded. A decision to transfer to 100% chrome crust, vegetable crust or fringe tanned vegetable leather would, however, place some strain upon the sammying, setting and drying facilities.

At the lowest level of production it is estimated that drying will take place in an open sided shed, which may have louvres to permit good ventilation. Frames and toggles will be used to maintain the shape of the hide, and some extra heat will be available at least in Model B. In Models C and D a tunnel will be employed with a current of hot dry air entering at one end. Again frames and toggles will be used, as they are simpler to operate than paste or vacuum methods. It must be remembered that, on the assumptions made, 75% of the through-put will be dried at some stage of processing. Chrome leathers are usually dried at higher temperatures than vegetable tanned leathers and it may well be that the product mix proposed for illustrative purposes would give rise to some problems in practice. This must be borne in mind when an actual plant is considered.

PRODUCTS AND OPTIONS AVAILABLE

The output of Models C and D and to some extent B, although limited in range, should be, given adequate raw material, of a standard and quantity sufficient to interest merchants and finishing plants in the developed world. That of Model A, in view of the very small quantities involved, would either be marketed through a co-operative or parastatal organisation or be regarded simply as an import substitute, if a manufacturing industry is present which can absorb its output.

Grades and weights of cattlehides in normal export selections typically cover some 50 or 60 categories, with another 60 classifications of goatskins and sheepskins. There is no internationally accepted standard for grading, but normally, hides are categorised firstly by origin (cowhides, bullhides, oxhides and so on), secondly by weight within each category (extra light, light, medium and heavy) and thirdly by quality with each weight range (firsts, seconds, thirds and rejections). Further divisions are made in terms of treatment (pickled, wet blue, vegetable crust). In view of the fact that the normal minimum consignment of any particular specification traded is of the order of 500 pieces of cattlehides (or 500 dozen sheep or goatskins), it would not be unexpected for the stock available for sale to total some 50 000 cattlehides if a good selection is to be maintained.

In terms of output period this represents for Model A 2 years production, for Model B 6 months, for Model C 10 weeks and for Model D 5 weeks. On this basis therefore in Model B, and to some extent even in Model C, it would be found that direct trading on the open market might carry penalties in terms of stock tied up and it may be found preferable to deal through an intermediary able to combine compatible output from a number of areas.

The value added to raw hides at various successive stages of processing may vary with local considerations such as the state of the livestock industry, cost of labour and services; and considerations such as the provision of additional employment or a market for locally produced chemicals may influence an investment decision. Under Indian conditions it has been stated that the value of raw hides is increased by 20% by pickling, 25 – 30% by tanning and 50 – 250% by finishing. Compared with this, the respective appreciation in value of hides required to achieve the 15% profit allowed for in Table 1, row 27, is 135% for Model A, 123% for Model B, 116% for Model C and 109% for Model D. In absolute terms these figures do not carry much weight but compared one with another they emphasise the point that modern tannery techniques have considerable economies of scale. In the cost models all output is expressed in terms of m^2 of finished leather. As is shown in the notes to Table 2, row 1, semi-finished output has been adjusted to give a finished leather equivalent by the use of co-efficients prepared by J. A. Villa (Appendix 5, No.11). In Model A, therefore, the production of a higher proportion of finished leather would have the effect of increasing the output in terms of m^2 and reducing the percentage value added requirement to a more easily obtainable figure. Such production might call for a linked manufacturing unit for footwear or fancy goods.

In the Indian experience, wet blue chrome hides earn 3% less in foreign exchange than vegetable tanned leathers. In addition, freight charges for wet blue chrome are 50% higher than for crust leathers. Labour content is said to be comparatively low in chrome tannage, but this may not be true if a comparison is made with up-to-date fringe tanning methods.

In terms of ease of marketing, there appears at present to be very good demand for unfinished leathers in the wet blue state, since these can be finished for different purposes. Fringe vegetable tanning is not yet widely established but there are few technical problems to be overcome and, in the British trade at least, it is expected to become a major factor in view of its ease of handling and grading, cheapness of transport and flexibility of end processing. It is necessary once again to stress that a feasibility study must be undertaken to determine the most advantageous form of tanning compatible with available raw materials and that market research should be undertaken to ensure that any proposed output is saleable.

Chapter 4

Economics of production

CAPITAL COSTS: LAND AND BUILDING COSTS, PRICES OF AVAILABLE MACHINERY AND WORKING CAPITAL

The costs used throughout this report are based on a specific developing country in SE Asia for which a very full set of factor costs are available. Physical inputs are unlikely to vary greatly from place to place, although the application of factor costs from another country might yield results different from those established here.

The land assumed in the cost models (Table 2, rows 7–9) is on a modern industrial estate and the purchase of a lease of 99 years subject to an annual quit rent is provided for. In the case of Models A and B a disproportionately large area of land has been allowed because their comparatively labour intensive nature may require additional handling and working space. In the case of A the area was fixed by the minimum size of plot available and could otherwise have been decreased by 40 % The tannery building is of modern pre-stressed concrete and asbestos sheet construction and provision of all mains services are included in the building cost of £19 per m^2. Considerable economies in the price of land and buildings might be achieved in rural areas with less stringent planning requirements.

The estimated size of tannery buildings (Table 2, rows 3–5) has been based on figures figures established by J. A. Villa (see Appendix 5, No. 11) and 1 m^2 of floor space has been allowed for each 75 m^2 of finished leather production equivalent, using conversion coefficients for partly finished leather, as set out in the notes to Table 2. Of the total floor space 70% is devoted to production and the remainder to offices, stores, washrooms, workshops and so on. Of the production area 25 % is given over to liming and bating (pre-tanning), 10 % to tanning and the balance to the various finishing and drying processes.

In arriving at the total land area requirement in Models C and D, twice the tannery area has been allowed. In Models A and B special considerations have led to estimates for a greater proportion of land.

Controls on effluent disposal being fairly stringent in the area considered, an arbitrary sum of 25 % of the machinery cost has been allowed, but this figure will certainly be subject to very considerable variation depending on local health regulations, population density and so on.

No allowance has been made for the cost of housing for managerial staff or labour, nor for the purchase of any private transport. In the context of the area and country chosen for the models this did not appear appropriate but consideration should be given to these factors.

Machinery costs (Tables 3–6) have been supplied by manufacturers in Britain. Other sources of supply are available in Europe, India and Japan. Many machinery manufactures are prepared to provide technical assistance in the design and costing of tanneries for specific circumstances and tenders should be sought from reputable firms as part of any feasibility study. Over-sophisticated machinery should be avoided in view of problems and cost of maintenance and spare parts. Much tannery machinery in all parts of the world is giving satisfactory service at an advanced age and it is suggested that consideration be given to the advantages of robust, conventional and well tested equipment which has been in quantity production for some years. It should be remembered that many manufacturers will supply factory reconditioned second-hand machinery at about 60% of the price of new.

Unless stocks are carefully controlled working capital can become a dangerously large item. In the cost models (Table 1, row 9) it is made up of 3 months' supply of raw hides and chemicals and 1 month's expenditure on other items, but a build-up of stocks, particularly if unsold rejections are held for long periods, could increase the total significantly. Interest on working capital (Table 1, row 22) is charged at 8 % as an operating cost. In the models the assumption is made that a market exists which can accept all output on monthly settlement terms. In an actual feasibility study it may become apparent that large stocks must be held, or that payment will be irregular or delayed. It is important that, in such cases, a realistic assessment of working capital required should be made, as this may have a serious effect both upon the capital and operating budgets.

OPERATING COSTS

Price of hides

It is particularly important, in view of the high proportion of operating costs represented by hides, that adequate local information is available on this item. In preparing the cost models difficulty has been experienced in selecting representative average prices from the information available. It has been assumed (Table 7) that adequate supplies of medium sized cattlehides of 10.5 kg wet salted weight are available at a collected cost of £1.85 each. The quality of raw hides from similar sources within the same country may be extremely variable. Actual grading percentages prepared by Government graders from two similarly equipped slaughterhouses within an African country have been published as follows:

	Slaughterhouse	
	A	B
Grade I	32	77
Grade II	60	15
Grade III	6	7
Rejects	2	1

and it must be assumed that from uncontrolled small-scale slaughterings the variation will be much greater.

It is important, therefore, to examine local sources of supply not only in terms of availability but of grading. No incentive scheme for the encouragement of better quality hides has been included in the cost models, but in a feasibility study it would be proper to consider how a premium payment for quality hides could be administered.

Price of chemicals

Table 8 lists prices of chemicals fob British ports together with cif prices where applicable. The country used as the basis for the cost models had no indigenous vegetable tannins suitable for the export trade, so that the import of wattle extract from East Africa was assumed. Lime, salt and sulphuric acid were available locally. In preparing a feasibility study, tenders would be invited for the supply of chemicals quarterly or half-yearly. It is preferable to specify exact requirements in most cases, as there is a natural tendency amongst suppliers sometimes to advocate chemicals of a grade and type superior in purity and cost to that which is necessary.

Cost of labour

Local labour costs (Table 10) have been applied uniformly to the models with the exception of Model A where the salaries of manager, technologist and supervisory staff have been reduced slightly to reflect the element of low cost family labour that is likely to be found in an enterprise of this size. Wages paid to clerical staff, semi-skilled and unskilled workers are the same in each model.

No costs have been included for the training of staff, or any initial employment of expatriates. Heavy additional expenses might be incurred in the employment of such persons. Educational courses in tanning management and leather technology are available in Britain and the possibility of sending personnel on these must be considered.

Transport

In the cost models, because of irregularities in transport requirement caused by variations in slaughter volume and infrequent deliveries of chemicals, it has been convenient to treat all transport as hired (Table 1, row 19), and consider it as an operating cost. Allowance has been made for the hire of commercial vehicles at 3.25p/tonne/kilometre assuming an average round trip of 60 km. Of the transport requirement 55 % relates to the collection of hides, 25 % to the delivery of processed goods and 20 % to the collection of chemicals. No allowance has been made for any back loading, but full loads have been assumed in all cases. In practice, unless there are long periods with no transport requirement at all, it may be considered preferable for the tannery to run at least part of its own transport requirements, topping up by hiring as necessary.

Power and water supply

In the cost models (Table 9) a three phase public supply of electricity is available and Models B, C and D had sufficient consumption to benefit from favourable industrial tariffs. Electricity charges and tariff structures vary widely and advice should be sought locally on such matters as the installation of capacitors when there is a high demand charge for maximum kVa. Under certain variable block tariffs, shift working is favoured. An allowance of 5 % has been made for lighting and office consumption which may be metered separately and to cover possible surcharges imposed for fuel cost variations. Water supply (Table 7, rows 6–8) is particularly abundant and cheap in the area chosen for the cost models, but in many countries this item would assume more formidable proportions. Care must be taken in siting a tannery that the supply of suitable water is not likely to become a limiting factor on planned expansion.

Where water shortage is a problem, consideration might be given to the tanning techniques known as 'low-float' and 'no-float' in which hides are drummed with a minimum of water. Advocates of these techniques claim that, apart from benefits in reduction of water consumption and effluent disposal charges, better use is made of tanning materials because more satisfactory penetration is achieved than with orthodox systems.

Attention might also be paid to the possibility of recycling water reclaimed from an effluent treatment system such as that outlined in Chapter 2. Such a policy would imply additional capital expenditure on purification plant and, probably, increased net operating costs.

Because good public supplies of both electricity and water are available, consideration has not been given in the models to provision of private supplies, but in certain areas it may be necessary to install some generating capacity or consider the drilling of a borehole or construction of a dam. Generating electricity is widely practised in remote areas and presents no insuperable problems, but the provision of a private water supply for tanning purposes should not be lightly undertaken, in that the suitability of the water must be proved by analysis and a continuing guard maintained against the possibility of contamination.

PRICES OF PRODUCTS

Leather prices fluctuate so sharply and have so wide a range depending upon quality and type that only a tentative forecast of anticipated level of profit at current prices has been made. In addition, for each cost model in row 27 of Table 1, the average price for each m^2 of finished leather required to yield a 15 % return on capital invested is shown. This is intended as a means of comparison between models rather than an indication of prices that may be achieved in practice. No provision has been made at this stage for company taxation. It will normally be necessary to use a greater mark up than 15 % in order to allow for the incidence of tax.

In a feasibility study it would be possible to relate prices of anticipated production to comparable leathers on the market and to confirm these by research in potential markets. It should be noted that the layout of tables in this report differs from that used with the discounted cash flow method, which should be applied in actual feasibility surveys. In DCF calculations the initial capital cost can be compared with operating costs over a period of time and set against anticipated income. By the use of appropriate factors, costs and benefits expected in the future can be given present day values and direct comparisons made between projects of widely dissimilar size and scope.

Table 1

Capital and operating costs

Values in £ sterling: late 1972

	All models single shift working Number of raw hides per day	Model A 100	Model B 400	Model C 1 000	Model D 2 000
	Capital costs				
1	Land	4 200	8 400	14 700	29 400
2	Buildings	10 700	41 800	104 100	208 300
3	Machinery and equipment	18 300	89 500	231 300	398 700
4	Ancillary services and effluent disposal	4 600	22 400	57 800	99 700
5	Spare parts	3 400	16 800	43 400	74 800
6	Installation cost	600	2 800	7 200	12 500
7	Contingencies	2 100	9 100	22 900	41 200
8	Total fixed capital	43 900	190 800	481 400	864 600
9	Working capital	16 700	63 900	156 500	307 800
10	Total capital invested	60 600	254 700	637 900	1 172 400
	Operating costs				
11	Raw hides	44 400	177 600	444 000	888 000
12	Chemicals, oils and dyes	12 100	47 000	114 500	222 900
13	Water	700	2 700	6 800	13 500
14	Electricity	1 000	4 400	10 100	16 100
15	Spare parts	1 700	8 400	21 700	37 400
16	Manpower	18 200	44 400	75 900	128 600
17	Maintenance	2 700	12 400	31 900	55 800
18	Insurance and administration	900	4 000	10 000	18 500
19	Collection and distribution	1 000	3 800	9 600	19 200
20	Rent	100	200	300	600
21	Unforeseen	4 100	15 200	36 200	70 000
22	Interest on working capital	1 300	5 100	12 500	24 600
23	Total operating cost	88 200	325 200	773 500	1 495 200
24	**Sinking fund** (a) Land	300	700	1 200	2 400
	(b) Buildings	1 000	3 900	9 800	19 500
	(c) Machinery	3 100	14 800	39 700	68 400
	(d) Total (a)—(c)	4 400	19 400	50 700	90 300
25	Total outlay	92 600	344 600	824 200	1 585 500
26	Cost per m^2 output	2.11	1.96	1.88	1.80
27	Selling price to achieve 15 % profit	2.32	2.18	2.09	2.00
28	Percentage profit at current selling price	2.29	12.31	18.14	25.10

Sources and notes for Table 1

Row 1	see Table 2
Row 2	see Table 2
Rows 3–6	see Tables 3–6
Row 7	5 % of rows 1–6
Row 8	Sum of rows 1–7
Row 9	¼ (3 months) of rows 11 and 12, plus $^1/_{12}$ (1 month) of rows 13–21
Row 10	row 8, plus row 9
Row 11	see Table 7
Row 12	see Table 8
Row 13	see Table 7
Row 14	see Table 9
Row 15	Annual requirement, ½ row 5
Row 16	see Table 10
Row 17	2.5 % of rows 1 and 2, plus 10 % of rows 3 and 4
Row 18	1.5 % of row 8 plus 0.5 % of rows 11 and 12
Row 19	Hired transport at 3.25p/t/km for rawhide, finished leather and chemicals, assuming an average round trip of 60 km
Row 20	See Table 2
Row 21	5 % of sum of rows 11–20
Row 22	8 % of row 9
Row 23	Sum of rows 11–22
Row 24	The sinking fund is calculated from the formula: $S(L) = \frac{P(L)r(1+r)^n}{(1+r)^n\ 1}$ where S(L) = sinking fund contribution for land (row 1) P = initial capital cost r = rate of interest (taken to be 8 %) n = no. of years to terminal value (99 years period of lease) $S(L) = \frac{(P) \times 0.08 \times (1.08)^{99}}{1.08^{99}\ 1} = P(L) \times 0.08004$ S(b) = sinking fund contribution for buildings (row 2) where n = 25 = P(b) x 0.0937 S(m) = sinking fund contribution for machinery (rows 3–6) where n = 15 = P(m) x 0.1168
Row 25	row 23, plus 24 (d)
Row 26	row 25 divided by annual output, expressed as m^2 of finished leather using appropriate co-efficients for semi-finished production (see Table 2)
Row 27	row 25 plus 15 % of row 10 divided by output, expressed as m^2 of finished leather. Note that this is merely used for the purpose of comparison and is not a recommended rate of profit.
Row 28	Rates of profit at current average selling price of finished upper leather (£2.14 m^2) in the S E Asian country from which factor costs have been taken, expressed as a percentage of row 10.

Table 2

Tannery buildings and land requirements and costs

Values in £ sterling: late 1972

		Unit	Model A	Model B	Model C	Model D
1	Daily tannery output expressed as finished leather	m^2	183	732	1 830	3 660
2	Annual output	m^2	43 920	175 680	439 200	878 400
3	Total area of tannery buildings	m^2	600	2 350	5 850	11 700
4	Production area	m^2	420	1 645	4 095	8 190
5	Area of offices, ancillary services etc	m^2	180	705	1 755	3 510
6	Building cost	£	10 680	41 830	104 130	208 260
7	Land area required	ha	0.5	1.0	1.75	3.5
8	Premium payment	£	4 200	8 400	14 700	29 400
9	Rent	£	85	170	300	600

Sources and notes for Table 2

Row 1 Conversion coefficients have been applied to the input of rawhide, according to the type of production, in order to express all production in terms of finished leather (J. A. Villa: see Appendix 5). For each 100 hides:

No	*Description*		*Size raw hide*			*Coefficient*		*Daily output*
50	Wet blue or fringe veg	×	2.4 m^2	= 120 m^2	×	0.33	=	40 m^2
50	Finished	×	2.4 m^2	= 120 m^2	×	1.00	=	120 m^2
80	Splits finished	×	0.8 m^2	= 64 m^2	×	0.36	=	23 m^2
								183 m^2

Row 2 240 days of single shift working

Row 3 1 m^2 total floor space for each 75 m^2 finished leather of medium sized hides (for large hides 1 m^2 would have been allowed for 85 m^2 finished leather, and for small hides 1 m^2 for 65 m^2 finished leather).

Row 4 70 % of row 3.

Row 5 30 % of row 3.

Row 6 Row 4 at £19 per m^2 + row 5 at £15 per m^2.

Row 7 For models C and D this has been calculated at three times the area of the tannery. On this basis Model B would have an area of 0.7 hectares but, in view of the higher labour content of the operations, it has been thought prudent to allow some extra land in case additional low cost building becomes necessary to accommodate some of the tanning operations. In the case of Model A these considerations also apply but the area is determined by the minimum size of industrial site available in the area chosen for the cost models. In other circumstances the area of Model A could be reduced to 0.3 ha.

Row 8 Premium payment of £8 400 per ha purchases 99 year lease.

Row 9 Annual quit rent of £170 per ha.

Table 3

Plant requirements and hp demand

Tannery Model A 100 hides per day (50 finished)

Values in £ sterling: late 1972

	Operation	Equipment	hp of electric motor	Number required	Unused capacity (no. of hides) at 85% efficiency	Total electric motors	Unit cost fob £	Total cost fob £	Cost cif £
	a	b	c	d	e	f	g	h	i
	Rawhide store								
1	Weighing	Yardarm	–	1	–	–	20	20	–
2	Transport	By hand	–	–	–	–	–	–	–
	Limeyard								
3	Soaking and liming	Drum 2 400 mm x 2 700 mm 2 rpm 24 hour operation	7.5	1	–	7.5	1 850	1 850	–
4	Fleshing	Fleshing machine 2 700 mm	20.0	1	500	20.0	10 900	10 900	–
5	Splitting	Not carried out	–	–	–	–	–	–	–
6	Weighing	Rawhide store equipment	–	–	–	–	–	–	–
7	Transport	By hand	–	–	–	–	–	–	–
	Tanyard								
8	Tanning	Drum 2 400 mm x 2 700 mm 8 rpm 24 hour operation	10	1	–	10	1 935	1 935	–
9	Weighing	Rawhide store equipment	–	–	–	–	–	–	–
	Finishing								
10	Sammying	Not carried out	–	–	–	–	–	–	–
11	Shaving	By hand	–	–	–	–	–	–	–
12	Dyeing	Drum 2 400 mm x 1 200 mm 14 rpm	5	1	–	5	1 570	1 570	–
13	Setting	By hand	–	–	–	–	–	–	–
14	Staking	By hand	–	–	–	–	–	–	–
15	Drying	Shed drying – frames and toggles	–	–	–	–	–	–	–
16	Buffing	Not carried out	–	–	–	–	–	–	–
17	Spraying	By hand	–	–	–	–	–	–	–
18	Seasoning	By hand	–	–	–	–	–	–	–
19	Pressing	Not carried out	–	–	–	–	–	–	–
20	Measuring	By squared frame	–	–	–	–	–	–	–
21	Total of tanning machinery		–	–	–	43	–	16 275	18 300[1]
22	Allowance for general services, machine shop, boilers, compressors, lighting, pumps etc at 25 %		–	–	–	11	–	4 070	4 580[1]
23	TOTAL[2]		–	–	–	54	–	20 345	22 880[1]

Sources: British manufacturers

Footnote:

(1) Obtained by adding 12½ % to fob total

(2) Not including spares required = 15 % of cif total = £3 400 and installation = 2½ % = £600

Table 4

Plant requirement and hp demand

Tannery Model B 400 hides per day (200 finished)

Values in £ sterling: late 1972

	Operation	Equipment	hp of electric motor	Number required	Unused capacity (no. of hides) at 85% efficiency	Total hp electric motors	Unit cost fob £	Total cost fob £	Cost cif £
	a	b	c	d	e	f	g	h	i
	Rawhide store								
1	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
2	Transport	Fork-lift truck, 2 tonne lift	Diesel/ propane	1	–	–	2 400	2 400	–
	Limeyard								
3	Soaking and liming	Drums 2 400 mm x 2 700 mm 2 rpm 24 hour operation	7.5	5	–	38	1 850	9 250	–
4	Fleshing	Fleshing machine 2 700 mm	20.0	1	200	20	10 900	10 900	–
5	Splitting	Bandknife splitting machine 2 700 mm	15.0	1	100	15	8 800	8 800	–
6	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
7	Transport	Rawhide store equipment	–	–	–	–	–	–	–
	Tanyard								
8	Tanning	Drums 2 400 mm x 2 700 mm 8 rpm 24 hour operation	10.0	6	–	60	1 935	11 610	–
9	Weighing	Limeyard equipment	–	–	–	–	–	–	–
	Finishing								
10	Sammying	Sammying machine 1 800 mm	10.0	3	100	30	6 670	20 010	–
11	Shaving	Wide shaving machine 1 500 mm	40.0	1	150	40	10 860	10 860	–
12	Dyeing	Drums 2 400 mm x 1 200 mm 14 rpm	5.0	2	–	10	1 570	3 140	–
13	Setting	By hand	–	–	–	–	–	–	–
14	Staking	By hand	–	–	–	–	–	–	–
15	Drying	Shed drying – frames and toggles	–	–	–	–	–	–	–
16	Buffing	Not carried out	–	–	–	–	–	–	–
17	Spraying	By hand	–	–	–	–	–	–	–
18	Seasoning	By hand	–	–	–	–	–	–	–
19	Pressing	Not carried out	–	–	–	–	–	–	–
20	Measuring	Pin-wheel measuring machine 1 625 mm	1.0	1	100	1	2 200	2 200	–
21	Total of tanning machinery		–	–	–	214	–	79 570	89 520[1]
22	Allowance for general services, machine shop, boilers, compressors, lighting, pumps etc at 25 %		–	–	–	54	–	19 890	22 380[1]
23	TOTAL[2]		–	–	–	268	–	99 460	111 900[1]

Sources: British manufacturers

Footnote: (1) Obtained by adding 12½ % to fob total
(2) Not including spares required = 15 % of cif total = £16 780 and installation = 2½ % = £2 800

Table 5

Plant requirements and hp demand

Tannery Model C 1 000 hides per day (500 finished)

Values in £ sterling: late 1972

	Operation	Equipment	hp of electric motor	Number required	Unused capacity (no. of hides) at 85 % efficiency	Total hp electric motors	Unit cost fob £	Total cost fob £	Cost cif £
	a	b	c	d	e	f	g	h	i
	Rawhide store								
1	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
2	Transport	Fork-lift truck, 2 tonne lift	Diesel/ propane	1	–	–	2 400	2 400	–
	Limeyard								
3	Soaking and liming	Drums 2 400 mm x 2 700 mm 2 rpm 24 hour operation	7.5	13	–	98	1 850	24 050	–
4	Fleshing	Fleshing machine 2 700 mm	20	2	200	40	10 900	21 800	–
5	Splitting	Bandknife splitting machine 2 700 mm	15	2	–	30	8 800	17 600	–
6	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
7	Transport	Fork-lift truck, 2 tonne lift	Diesel/ propane	1	–	–	2 400	2 400	–
	Tanyard								
8	Tanning	Drums 2 400 mm x 2 700 mm 8 rpm 24 hour operation	10	14	–	140	1 935	27 090	–
9	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
	Finishing								
10	Sammying	Sammying machine 1 800 mm	10	5	–	50	6 670	33 350	–
11	Shaving	Wide shaving machine 1 500 mm	40	2	200	80	10 860	21 720	–
12	Dyeing	Drums 2 400 mm x 1 200 mm 14 rpm	5	5	–	25	1 570	7 850	–
13	Setting	Setting machine 1 830 mm	12.5	2	150	25	7 725	15 450	–
14	Staking	Staking machine 1 600 mm	4	1	–	4	2 500	2 500	–
15	Drying	Tunnel drying, frames and toggles	7	1	–	7	6 250	6 250	–
16	Buffing	Buffing machine 600 mm c/w dust extractor	15	1	–	15	4 365	4 365	–
17	Spraying	Spraying machine c/w drying tunnel	4	1	500	4	2 500	2 500	–
18	Seasoning	Seasoning conveyor c/w drying tunnel	4	1	–	4	1 250	1 250	–
19	Pressing	Hydraulic press platen 1 370 mm x 1 000 mm	20	1	500	20	10 045	10 045	–
20	Measuring	Pin-wheel measuring machine 1 625 mm	1	2	250	2	2 200	4 400	–
21	Total of tanning machinery		–	–	–	544	–	205 620	231 320[1]
22	Allowance for general services, machine shop, boilers, compressors, lighting, pumps etc at 25 %		–	–	–	136	–	51 405	57 830[1]
23	TOTAL[2]		–	–	–	680	–	257 025	289 150[1]

Sources: British manufacturers

Footnote:

(1) Obtained by adding 12 ½ % fob total.

(2) Not including spares required = 15 % of cif total = £43 380, and installation = 2½ % = £7 230

Table 6

Plant requirement and hp demand

Tannery Model D 2 000 hides per day (1 000 finished)

Values in £ sterling: late 1972

	Operation	Equipment	hp of electric motor	Number required	Unused capacity (no. of hides) at 85 % efficiency	Total hp electric motors	Unit Cost fob £	Total Cost fob £	Cost cif £
	a	b	c	d	e	f	g	h	i
	Rawhide store								
1	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
2	Transport	Fork-lift truck, 2 tonne lift	Diesel/ propane	1	–	–	2 400	2 400	–
	Limeyard								
3	Soaking and liming	Drums 2 400 mm x 2 700 mm 2 rpm 24 hour operation	7.5	26	–	195	1 850	48 100	–
4	Fleshing	Fleshing machine, 2 700 mm	20	3	–	60	10 900	32 700	–
5	Splitting	Bandknife splitting machine 2 700 mm	15	4	–	60	8 800	35 200	–
6	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
7	Transport	Fork-lift trucks, 2 tonne lift	Diesel/ propane	1	–	–	2 400	2 400	–
	Tanyard								
8	Tanning	Drums 2 400 mm x 2 700 mm 8 rpm 24 hour operation	10	27	–	270	1 935	52 245	–
9	Weighing	Platform scales 1 800 mm x 1 200 mm	–	1	–	–	200	200	–
	Finishing								
10	Sammying	Sammying machine 1 800 mm	10	10	–	100	6 670	66 700	–
11	Shaving	Wide shaving machine 1 500 mm	40	3	–	120	10 860	32 580	–
12	Dyeing	Drums 2 400 mm x 1 200 mm 14 rmp	5	10	–	50	1 570	15 700	–
13	Setting	Setting machine 1 830 mm	12.5	3	–	38	7 725	23 175	–
14	Staking	Staking machine 1 600 mm	4	2	–	8	2 500	5 000	–
15	Drying	Tunnel drying – frames and toggles	7	1	–	7	8 500	8 500	–
16	Buffing	Buffing machine 600 c/w dust extractor	15	2	–	30	4 365	8 730	–
17	Spraying	Spraying machine c/w drying tunnel	4	1	–	4	2 500	2 500	–
18	Seasoning	Seasoning conveyor c/w drying tunnel	4	1	–	4	1 250	1 250	–
19	Pressing	Hydraulic press platen 1 370 mm x 1 000 mm	20	1	–	20	10 045	10 045	–
20	Measuring	Pin-wheel measuring machine 1 625 mm	1	3	–	3	2 200	6 600	–
21	Total of tanning machinery		–	–	–	969	–	354 425	398 730[1]
22	Allowance for general services, machine shop, boilers, compressors, lighting, pumps etc at 25 %		–	–	–	242	–	88 610	99 680[1]
23	TOTAL[2]		–	–	–	1 211	–	443 035	498 410[1]

Sources: British manufacturers

Footnotes:

(1) Obtained by adding 12½ % to fob total

(2) Not including spares required = 15 % of cif total = £74 760 and installation = 2½ % = £12 460

Table 7

Rawhide requirements and cost: water consumption and cost

Values in £ sterling: late 1972

		Model A	Model B	Model C	Model D
1	Number of wet salted hides processed per day	100	400	1 000	2 000
2	Number of wet salted hides processed per year	24 000	96 000	240 000	480 000
3	Tonnes wet salted hides processed per day	1.05	4.20	10.50	21.00
4	Tonnes wet salted hides processed per year	252	1 008	2 520	5 040
5	Annual cost of hides (£)	44 400	177 600	444 000	888 000
6	Litres water consumed ('000)	12 600	50 400	126 000	252 000
7	Gallons ('000)	2 780	11 086	27 716	55 433
8	Annual cost of water supply (£)	680	2 700	6 750	13 500

Sources: Local sources see text pages 31, 32 and 33

Notes:

Row 2	240 days worked; single shift
Row 3	at 10.5 kg per hide
Row 5	at £1.85 each
Row 6	at 525 litres per hide
Row 8	at £0.243 per 1 000 gallons

Table 8

Chemicals, oils and dyes: requirements and costs

Values in £ sterling: late 1972

Item	Inputs expressed in kg per tonne rawhide				UK cost[1] per tonne fob (£)	S E Asia[2] cost per tonne (£)	Consumption (tonnes)				Cost (£)			
	Wet Blue	Fringe vegetable tanned	Wet blue finished	Fringe vegetable tanned-finished			Model A	Model B	Model C	Model D	Model A	Model B	Model C	Model D
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
1 Sodium hypochlorite	10	10	–	–	30	39	2.52	10.08	25.20	50.40	98	393	983	1 966
2 Lime (calcium hydroxide)	30	30	–	–	13	13	7.56	30.24	75.60	151.20	98	393	983	1 966
3 Sodium sulphide	25	25	–	–	70	91	6.30	25.20	63.00	126.00	573	2 293	5 733	11 466
4 Ammonium chloride	15	15	–	–	46	60	3.78	15.12	37.80	75.60	227	907	2 268	4 536
5 Synthetic pancreatic bate	10	10	–	–	97	126	2.52	10.08	25.20	50.40	318	1 270	3 175	6 350
6 Sodium chloride	150	–	–	–	15	15	18.90	75.60	189.00	378.00	284	1 134	2 835	5 670
7 Sulphuric acid	15	–	–	–	20	20	1.89	7.56	18.90	37.80	38	151	378	756
8 Chrome powder	100	–	–	60	105	136	16.38	65.52	163.80	327.60	2 227	8 911	22 276	44 553
9 Sodium bicarbonate	10	–	–	–	36	47	1.26	5.04	12.60	25.20	59	237	592	1 184
10 Mimosa extract	–	100	–	–	100	115	12.60	50.40	126.00	252 00	1 449	5 796	14 490	28 980
11 Dye (standard mid-brown)	–	–	10	10	1 300	1 690	1.26	5 04	12 60	25 20	2 129	8 518	21 294	42 588
12 Sulphonated sperm oil	–	–	40	40	150	195	5.04	20.16	50.40	100.80	983	3 931	9 828	19 656
13 Finish	–	–	50	50	215	280	6.30	25.20	63.00	126.00	1 764	7 056	17 640	35 280
14 Seasoning	–	–	20	20	550	715	2.52	10.08	25.20	50.40	1 802	7 207	18 018	36 036
15 Total	–	–	–	–	–	–	88.83	355.32	888.30	1 776.60	12 066	48 197	120 493	240 987
16 Quantity discounts[3]	–	–	–	–	–	–	–	–	–	–	–	1 206	6 033	18 099
17 Net total	–	–	–	–	–	–	–	–	–	–	12 066	46 991	114 460	222 888

Sources: British merchants and local sources

Footnotes:
(1) 2–5 tonne lots
(2) cif + import duty at 15 %, except rows 2, 6, 7 where there is domestic production. Row 10, imported directly from E Africa is increased only by import duty.
(3) Model B 2½ %; Model C 5 %; Model D 7½ %

Table 9

Electricity requirements and costs[1]

Values in £ sterling: late 1972

		Model A	Model B	Model C	Model D
1	Total hp installed	54	268	680	1 211
2	Maximum demand kVa	40	200	500	900
3	Units consumed per month[2]	5 440	27 200	68 000	122 400
4	Tariff applicable	*Non-industrial fixed block tariff* (under 10 000 units per month)		*Fixed block industrial tariff*	
		First 500 units 1.621p Next 4 500 units 1.459p Each additional unit 1.378p		First 50 000 units per month 1.297p Each additional unit 0.867p	
5	Calculation of monthly expenditure	500 @ 1.621p = £8.105 4 500 @ 1.459p = £65.655 440 @ 1.378p = £6.063	27 200 @ 1.297p = £352.784	50 500 @ 1.297p = £648.500 18 000 @ .867p = £156.060	50 000 @ 1.297p = £648.500 72 400 @ 876p = £627.708
6	Monthly cost	79.823	352.784	804.560	1 276.208
7	Average 5 % surcharge (power factor) surcharge and fuel cost variation)	3.991	17.639	40.228	63.810
8	Monthly total	83.814	370. 423	844.788	1 340.018
9	Annual total	£1 000.000	£4 400.000	£10 100.000	£16 100.000

Sources: Local tariff

Footnotes:

(1) Calculated on cheapest available tariff. An alternative tariff which might be more favourable in Models B, C and D if more than one shift were to be worked is:

First 10 units per month per kw of maximum demand	3.242p
Next 150 units per month per kw of maximum demand	1.256p
Next 150 units per month per kw of maximum demand	0.973p
Next 150 units per month per kw of maximum demand	0.892p
Each additional unit per month	0.811p

(2) Assuming 240 days worked per year at 85 % efficiency on a single 8 hour shift. Although in some instances throughput is below 85 % of rated capacity, this occurs in the smaller models, where the further assumption is made that machines are less well managed and running time is in excess of throughput.

Table 10

Manpower requirements and costs

Values in £ sterling: late 1972

		Model A						Model B						Model C						Model D					
1	Class of manpower[1]	a	b	c	d	e	f	a	b	c	d	e	f	a	b	c	d	e	f	a	b	c	d	e	f
2	Annual income[2]	2 000	800	450	750	330	230	2 400	1 000	450	900	330	230	2 400	1 000	450	900	330	230	2 400	1 000	450	900	330	230
3	Management	1	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	2	–	–	–	–	–
4	Technical	–	1	–	–	–	–	–	2	–	–	–	–	–	4	–	–	–	–	–	6	–	–	–	–
5	Clerical	–	–	2	–	–	–	–	–	5	–	–	–	–	–	9	–	–	–	–	–	12	–	–	–
6	Rawhide store	–	–	–	1	–	1	–	–	1	1	–	2	–	–	1	1	2	2	–	–	2	1	3	4
7	Limeyard	–	–	–	1	4	4	–	–	–	2	12	16	–	–	–	3	28	22	–	–	–	4	50	44
8	Tanyard	–	–	–	1	2	2	–	–	–	2	8	8	–	–	–	3	17	15	–	–	–	4	32	30
9	Finishing	–	–	–	1	12	–	–	–	–	4	23	–	–	–	1	6	37	6	–	–	2	8	72	12
10	Despatch	–	–	–	–	1	–	–	–	1	1	–	2	–	–	1	1	2	2	–	–	2	1	3	4
11	Ancillary	–	–	–	1	6	4	–	–	–	1	8	16	–	–	–	2	11	30	–	–	–	2	14	55
12	Total employees	1	1	2	5	25	11	1	2	7	11	51	44	1	4	12	16	97	77	2	6	18	20	174	149
13	Total payments annually	2 000	800	900	3 750	8 250	2 530	2 400	2 000	3 150	9 900	16 830	10 120	2 400	4 000	5 400	14 400	32 010	17 710	4 800	6 000	8 100	18 000	57 420	34 270
14	Total for each model	18 230						44 400						75 920						128 590					

Sources: Local sources, see text pages 32 and 33

Footnotes: (1) a = manager; b = technologist; c = clerical; d = supervisory; e = semi-skilled; f = unskilled
(2) Includes all supplementary (welfare etc) payments

Appendix 1

Tanning of sheepskins and goatskins

Although the main text and tables of this report refer (for convenience and simplicity of presentation) mainly to hides, it is intended to be of use also in the preliminary investigations of sheep and goatskin tanning projects.

For the purpose of converting the tables to give an application to the tanning of skins, Table 7 (rawhide requirements) is taken as the starting point. Skins are more often dried than wet salted but, for ease of conversion, one skin is taken to equal 2 kg wet salted and to have an area of 0.4 m². Goatskins tend to be slightly smaller than sheepskins, but it is suggested that the difference is not significant at this stage. The number of skins processed by each model is taken to be five times the number of hides, giving a comparable weight and allowing Table 8 to be unchanged. This means that output of finished leather in terms of m² is also taken to be unchanged, although it is recognised that this may vary greatly with the type of skin, offtake of splits, and end uses. Costs obtained for skins in the area in question appear to be low in relation to world prices and may not be reliable, but even so the raw material cost is increased by 10 %.

In the processing of some goatskins and, more particularly, sheepskins or 'pelts' degreasing is required. This is not normally necessary in cattlehides because of their low fat content.

Degreasing is normally carried out by drumming the pelts for 2 hours at 35 °C with about 30 % of their wet pickled weight of kerosene and 1 % of a non-ionic emulsifier. The kerosene may be recovered by fractional distillation and used again. The degreased pelts are next drummed for an hour with 20 % common salt and twice their wet weight volume equivalent of water at 35–40 °C. This liquor is discarded and replaced by the same quantities of salt and water. Drumming is continued for 30 minutes and then the liquor is again discarded and the pelts horsed up to drain. (The 'horse' is a trestle-like structure of wood or some other suitable material). The degreased, drained pelts are then de-pickled for vegetable tanning, or taken on to chrome tannage without further treatment.

De-pickling may be done by putting the pelts into a drum with 10 % salt and 200 % water (basis as before) and borax. The borax, in a 10 % aqueous solution, is added in small portions at 15-minute intervals until the pH is raised to about 4.5 or 5.0. The borax needed may be as much as 8 % of pelt weight. After being washed in running water to remove excess salts, the pelts are now ready for vegetable tannage.

Whether vegetable or mineral tanned, pickled or de-pickled, a light treatment with a synthetic organic tan (syntan) may be given before the main tannage.

It is assumed that the sheepskins available will be haired rather than woolled so that no special de-wooling plant is required and that the building and land requirements listed in Table 2 will not require altering. In fact the output in terms of m^2 produced may be up to 10 % less than in the hide tanning but until more reliable estimates are obtained it is suggested that Table 2 be unchanged.

The costs of machinery installed and of direct labour need to be increased substantially because of the comparatively large number of units to be processed and handled and in Table 11, which follows, costings are provided at appropriate rates. Machinery requirements are similar to those for cattlehides but equipment of smaller working width is adequate. For example, the fleshing machine for cattlehides may have a working width of 2 700 mm and that for sheep or goatskins 1 900 mm. The throughput on the other hand is of the order of 600 units for cattlehides and 1 100 for sheep or goatskins.

Since the equipment for a sheepskin or goatskin tannery, particularly in the finishing department, tends to be orientated towards specific end uses and therefore somewhat specialised, machinery requirements are not given in detail. In a feasibility study, however, it will be necessary, having related available raw material to potential markets, to prepare detailed specifications.

Electricity consumption may remain at the same level; the lower consumption per skin, as compared to per hide, compensating in part for the greater number of skins processed.

Revised figures indicating the comparative order of costs when the models are converted to sheepskin tanning are given in Table 11.

Table 11

Capital and operating costs related to tanning of skins

All models single shift working

Values in £ sterling: late 1972

		Model A	Model B	Model C	Model D
	Number of raw skins per day	500	2 000	5 000	10 000
	Capital costs				
1	Land	4 200	8 400	14 700	29 400
2	Buildings	10 700	41 800	104 100	208 300
3	Machinery and equipment	23 800	116 300	300 700	518 300
4	Ancillary services and effluent disposal	6 000	29 100	75 200	129 600
5	Spare parts	4 500	21 800	56 400	97 200
6	Installation cost	700	3 600	9 400	16 200
7	Contingencies	2 500	11 000	28 000	50 000
8	Total fixed capital	52 400	232 000	588 500	1 049 000
9	Working capital	18 200	70 000	170 600	335 200
10	Total capital invested	70 600	302 000	759 100	1 378 600
	Operating costs				
11	Raw skins	48 800	195 400	488 400	976 800
12	Chemicals, oils and dyes	12 100	47 000	114 500	222 900
13	Water	700	2 700	6 800	13 500
14	Electricity	1 000	4 400	10 100	16 100
15	Spare parts	2 200	10 900	28 200	48 600
16	Manpower	21 500	52 500	90 800	156 100
17	Maintenance	3 300	15 800	40 600	70 700
18	Insurance and administration	1 100	4 700	11 800	21 700
19	Collection and distribution	1 000	3 800	9 600	19 200
20	Rent	100	200	300	600
21	Unforeseens	4 600	16 900	40 000	77 300
22	Interest on working capital	1 500	5 600	13 600	26 800
23	Total operating cost	97 900	360 000	854 700	1 650 500
24	**Sinking fund** (a) Land	300	700	1 200	2 400
	(b) Buildings	1 000	3 900	9 800	19 500
	(c) Machinery	4 100	19 900	51 600	88 900
	(d) Total (a)–(c)	5 400	24 500	62 600	110 800
25	Total outlay	103 300	384 500	917 300	1 761 300
26	Cost per m^2 output	2.35	2.19	2.09	2.00
27	Selling price to achieve 15 % profit	2.59	2.45	2.35	2.24
28	Percentage profit at current selling price	–	–	–	–

Notes for Table 11

Row 1	Unchanged
Row 2	Unchanged
Rows 3–6	Increased by 30 %
Row 7	5 % of rows 1–6
Row 8	Sum of rows 1–7
Row 9	¼ of rows 11 and 12 plus $^{1}/_{12}$ of rows 13–21
Row 10	Row 8 plus row 9
Row 11	Increased by 10 % Local factor cost low compared with world prices
Row 12	Unchanged
Row 13	Unchanged
Row 14	Unchanged
Row 15	½ of row 5
Row 16	Table 10 plus 30 % categories e and f
Row 17	2.5 % of rows 1 and 2 plus 10 % of rows 3 and 4
Row 18	1.5 % of row 8 plus 0.5 % of rows 11 and 12
Row 19	Unchanged
Row 20	Unchanged
Row 21	5 % of rows 11–22
Row 22	8 % of row 9
Row 23	Sum of rows 11–22
Row 24	(a) Unchanged (b) Unchanged (c) Sum of rows 3, 4, 5 and 6 x 0.1168
Row 25	Row 23 plus row 24 (d)
Row 26	Row 25 divided by annual output expressed as m^2 finished leather (output per 500 skins = 37 200 m^2 annually)
Row 27	Row 25 plus 15 % of row 10 divided by annual output
Row 28	Price for finished leather not available

Appendix 2

Tanning recipes used in the cost models

The quantities of chemicals used in the cost models and set out in Table 8 are based on the following simple recipes. Whilst this report is in no sense a practical handbook of tanning practice, it may be helpful to give a slightly expanded account of the sort of process that would be suitable in a developing country.

The following quantities are expressed as percentage weights of the wet salted hide as received at the tannery.

Process	*Requirement*
Soaking and washing	1 500 % water with 1 % sodium hypochlorite
Liming and unhairing	500 % water, 3 % calcium hydroxide and 2.5 % sodium sulphide. This will remove hair effectively without the use of a dehairing machine.
Washing	1 000 % water.
Deliming and bating	500 % water at 35 °C with 1.5 % ammonium chloride and 1 % synthetic pancreatic bate.
Washing	1 000 % water.

Chrome tanning and fringe vegetable tanning processes now diverge. For fringe tanning, the only remaining operations are drumming with 10 % mimosa powder extract and rinsing with 300 % water. After sammying, setting out and drying, the process is now complete. Chrome tanning proceeds as follows:

Pickling	200 % water, 12 % sodium chloride and 1.5 % concentrated sulphuric acid.
Tanning	2.5 % chromic oxide (= 10 % chrome powder), 3 % sodium chloride and 1 % sodium bicarbonate.
Washing	500 % water.

The wet blue chrome process is now complete. Any wet blue leather that is to be finished can go directly to the finishing shop, but any fringe tanned leather that is to join it must first be wetted back with 300 % water at 35 °C and retanned by the chrome process.

Leather for finishing is now treated as follows:

Neutralising	200 % water at 50 °C with 2 % sodium bicarbonate.	
Dyeing	1 % mid-brown dye.	
Fat liquoring	4 % sulphonated sperm oil.	
Finishing	Pad coat of finish	130 cm^3/m^2
	1st Spray coat	85 cm^3/m^2
	2nd Spray coat	65 cm^3/m^2

(The finish is made up of 25 % polymer dispersion, 25 % pigment paste and 50 % water).

Top seasoning	Nitrocellulose emulsion 85 cm^3/m^2

Appendix 3

Forms of tanning other than by chrome and vegetable tanning agents

These notes outline some of the more widely used minor tanning agents.

Alum Aluminium salts can combine with the collagenous proteins of skin in a similar way to that of chromium salts. Ordinary aluminium salts, however, eg the sulphate, produce a *tawed* as distinct from a *tanned* product. When brought in contact with water, a tawed skin has no stability since the salts are leached out by the action of water. True tannage can, however, be effected with *basic* aluminium sulphate, in the presence of an organic acid such as tartaric acid with a consequent rise of up to 15 °C in the shrinkage temperature. Alum tannage is often used in conjunction with other tanning agents to obtain specific effects.

Zicronium Zirconium salts, used under acid conditions, give a rapid tannage of the grain surface of leather producing a wrinkled grain finish desired in some fashion leathers. Alternatively, in combination with organic salts which mask this effect, they will give a white leather and, unlike aluminium salts, are not easily washed out.

Aldehyde Formaldehyde, dissolved in water to give formalin, is used for tanning white, washable leathers from which the grain split has been removed. Without this precaution very rapid tannage of the grain surface takes place with no penetration. This characteristic is sometimes employed, under controlled conditions, to 'set' the grain of leather prior to tanning by some other agent.

Oil Flesh splits of sheepskin are tanned with raw cod liver oil to produce chamois leathers. Since the oil is not readily absorbed by the skin, it is necessary to apply it with a vigorous, mechanical hammering action followed by a period of conditioning in a warm unventilated area ('stoving') where oxidation of the oil takes place. Surplus oil is removed by squeezing and washing, leaving a leather with the well known characteristic of being able to absorb water readily and to be wrung out easily.

'Syntans' A number of synthetic tanning agents have been developed by the treatment of phenols, cresols or naphthalenes with formaldehyde or mineral acids. These give agents which by themselves, or in combination with vegetable tannins, yield leathers with the general feel of vegetable tannage but ranging in colour from buff to white and with some special features. Being comparatively expensive, they are used only when some such special characteristic as colour fastness or mould resistance is sought.

Appendix 4

Notes on some sources of hides and skins other than main species of domestic animals

Pigskins In spite of the world wide distribution of the pig and its large numbers, only a very small proportion of pigskins are utilised for tanning and they represent the major untapped source of raw material. Because the skin is relatively digestible, it is often left on the carcass to become pork crackling or bacon rind or, if removed, is converted into pet foods. The traditional use for pigskin leathers is for gloves, luggage and fancy goods (briefcases, wallets, handbags, etc.) but increasingly it is being used for shoe uppers. The wild pig of South America is also hunted for its skin which gives a leather of high quality used for clothing and gloves.

Game hides and skins In African countries in particular there is a considerable trade in elephant, monkey, cat species, zebra and antelope leathers which are often tanned with the hair on and made into articles for sale to the tourist trade, or sold in the salted condition for further specialised processing. Normal tanning processes are used, but liming and dehairing is omitted where it is desired to leave the hair on.

Reptile leathers Except in the case of the alligator, which is raised commercially in the United States and Australia, reptile leathers are obtained from wildlife species whose skins represent their only commercial value. The farming of crocodiles has also been carried out in Australia, Singapore and some African countries and may become of importance in the future. Major exporting areas are in East and Central Africa, India, Sri Lanka (Ceylon), Papua and New Guinea, and Central and South America. Although numbers of the hunted species are said to be declining, no effective controls appear to be operating. Crocodile skins are of especial value but lizard and snake, particularly python, skins are also in demand.

Because special tanning techniques are required and because the trade is closely linked to luxury and fashion articles, it seems likely that most processing will continue to be carried out in the principal consuming countries of Europe and North America.

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The market for gum arabic

A. D. Adamson and Jess-Mary K. Bell

une 1974

Tropical Products Institute 56/62 Gray's Inn Road London WC1X 8LU
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Contents

SUMMARY AND CONCLUSIONS page

Summary and conclusions 1

Sommaire et conclusions

Resumen y conclusiones

PART I INTRODUCTION 10

PART II PRODUCTION

General 11

Sudan 11

Grades 12

Gum tahl 13

Nigeria 13

Grades 13

Former French Territories in West Africa 14

Grades 15

Tanzania 16

Others 16

PART III INTERNAL MARKETING ORGANISATIONS

General 17

Sudan 17

Nigeria 18

Ex-French Territories 18

Senegal 18

Mauritania 19

Chad 19

Mali 19

Niger 19

Conclusion 19

PART IV PRICES 20

page

PART V USES 23

PART VI SUBSTITUTES

- Natural Gums 26
  - Plant exudates 26
  - Plant extracts 27
  - Seaweed extracts 27
  - Pectins 28
  - Gelatin 28
  - Starches 28
- Modified natural gums 28
  - Sodium carboxymethylcellulose 29
  - Methyl cellulose 29
  - Others 29
- Synthetic gums 29
  - Polyvinylpyrrolidone 29
  - Polyvinyl alcohol 30
  - Carbopol 30
- General 30
- Substitution by area of use 31
  - Confectionery 31
  - Flavours 31
  - Other food outlets 32
  - Pharmacy 32
  - Adhesives 32
  - Lithography 33
  - Paints 33
  - Inks 34
  - Textiles 34
  - Cosmetics 34

PART VII TRADE STRUCTURE

- General 35
- United Kingdom 36
- United States of America 37
- France 38
- Others 38
- Spray-dried gum arabic 38

PART VIII IMPORT DUTY 40

PART IX MARKETS

page
General 41
United Kingdom 41
Breakdown by area of use 42
- Confectionery 42
- Pharmacy 43
- Flavours 44
- Adhesives 44
- Lithography 44
- Paints 45

United States of America 45
Breakdown by area of use 45
- Confectionery 46
- Soft drinks 46
- Spray-dried flavours 46
- Pharmacy 46
- Others 47

France 47
Breakdown by area of use 47
- Confectionery 47
- Others 48

Italy 48
Breakdown by area of use 48
Netherlands 49
Breakdown by area of use 49
German Federal Republic 50
Breakdown by area of use 51
India 51
Breakdown by area of use 51
Japan 52
Breakdown by area of use 52
Belgium—Luxembourg 52
Breakdown by area of use 53
Australia 53
Breakdown by area of use 53
South Africa 53
Breakdown by area of use 54
Scandinavia 54
Denmark 54
Finland 54
Sweden 54

page

Norway 55

Total Scandinavian market 55

Other markets 55

The world market 55

Summary of market conditions 56

PART X PROSPECTS

Shortages and price increases 57

Quality 57

Processing at source 58

Outlook 58

REFERENCES 59

APPENDIX A: Importers of gum arabic 60

APPENDIX B:

Figure I: Gum arabic (Kordofan): Quarterly average prices (CIF London) 62

II (a): Gum arabic: Annual average prices per unit quantity of exports from selected countries 63

II (b): Gum arabic: Annual average prices per unit quantity of imports into selected countries. 64

APPENDIX C: Trade Statistics

Tables 1: Gum arabic: Exports from producing countries 65

2: Gum arabic (Hashab): Exports from Sudan 66

3: Gum arabic (Kordofan): Quarterly average prices and annual range (CIF London) 70

4: Gum arabic: Imports into the UK 71

5: Gum arabic: Re-exports from the UK 72

6: Gum arabic: Imports into the USA 74

7: Gum arabic: Imports into France 75

8: Gum arabic: Imports into Italy 76

9: Gum arabic: Imports into the Netherlands 77

10: Gum arabic: Imports into the German Federal Republic 78

11: Gum arabic: Imports into India 79

12: Gum arabic: Imports into Japan 80

13: Gum arabic and tragacanth: Imports into Belgium/ Luxembourg 81

14: Gum arabic: Imports into Australia 82

15: Gum arabic: Imports into South Africa 83

16: Gum arabic: Imports into Denmark 84

17: Gum arabic: Imports into Finland 85

18: Gum arabic: Imports into Sweden 86

APPENDIX C—continued

Table page

19: Gum arabic: Imports into Norway 87

Supplementary Statistical Tables: not referred to in text.

20: Gum arabic (Tahl): Exports from Sudan 88
21: Gum arabic (Dust): Exports from Sudan 89
22: Gum arabic: Exports from Nigeria 90
23: Gum arabic (Dure Terlo): Exports from Senegal 92
24: Gum arabic (Dure Kaedi): Exports from Senegal 93
25: Gum arabic (Dure Niger-Other): Exports from Senegal 94
26: Gum arabic: Exports from Tanzania 95
27: Gum amber and arabic: Imports into Canada 96
28: Gum arabic: Imports into Brazil 97
29: Gum arabic: Imports into Mexico 98
30: Gum arabic: Imports into the Argentine Republic 99

NOTE

Metric tons and kilogrammes are the units of weight used throughout this report and are abbreviated to tons and kg.

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The market for gum arabic

SUMMARY AND CONCLUSIONS

1. Gum arabic, or gum acacia as it is more correctly termed, is the exudate obtained from various species of the *Acacia* genus. For commercial purposes, only two of the species are significant: *Acacia senegal,* which produces the best type of gum and provides the vast bulk for world trade; and *Acacia seyal,* which produces a lower grade of gum.

This study attempts to assess the present market and future prospects for gum arabic in each of its major outlets in a number of markets.

2. The only area where there is commercial collection of gum arabic on a substantial scale is that part of Africa south of the Sahara desert. There are three important centres of production: Sudan, Nigeria, and the former French territories in West Africa.

World production of gum arabic followed a rising trend until 1965, when a peak of 67 200 tons was reached. Production has fallen slightly since then to a figure of 58 000 tons in 1971.

3. Largely as a result of its possession of pure stands of *Acacia senegal* and the consequent ease of collection, Sudan is the leading producer of gum arabic, supplying over the eleven year period up to 1971, between 74 % and 88 % of annual world requirements. Sudanese exports of gum arabic consist of two types: gum 'hashab' or 'verek', which is the exudate from *Acacia senegal,* and gum 'tahl', which is the exudate from *Acacia seyal.* Gum hashab accounted for an average of 89 % of total Sudanese exports of gum arabic in the years 1961–71.

On the basis of the estimated exports from Nigeria, its relative contribution to the world supplies of gum arabic has ranged from 4.2 % to 9.4 % in the years 1961–71. Its relative average annual contribution of 8.1 % of world exports since 1967 is evidence of the increasing popularity of gum from sources other than the Sudan.

The quality of Nigerian gum has traditionally been considered inferior to that of the Sudan, but this has largely been due to the less organised nature of the Nigerian trade.

The former French territories in West Africa (principally Senegal and Mauritania, but also Mali, Chad and Niger) provided over the years 1961–71 an average of 12 % of world supplies of gum arabic, but this proportion has varied considerably during the period. Until 1967 France took an average of 92 % of the supplies of this region, although in following years this proportion fell off considerably to 60 % in 1970. This again suggests that other large markets are increasingly seeking alternative sources of supply to the Sudan.

4. The internal marketing organisations in the countries of origin vary considerably in their degree of sophistication: generally, the greater the degree of organisation of the internal marketing system, the higher the reputation of the final product.

The marketing of gum arabic in the Sudan has been conducted under well-regulated government supervision for many years, culminating in the nationalisation of the industry in October 1969.

The marketing structure in the other countries varies from a degree of government control to a situation of total private enterprise. There is probably an increased tendency towards government supervision, which should result in the provision of gum of superior quality.

5. The major markets for gum arabic are the USA, the UK and France. Net imports in these countries are, respectively of the order of 12 000 tons, 6 000 tons and 8 000 tons. Imports into Italy, the Netherlands and the Federal Republic of Germany closely follow in importance and apart from India, which is rather a special case, there are another seven countries which regularly import over 1 000 tons of gum arabic per annum: Japan, Belgium-Luxembourg, Australia, South Africa, Denmark, Sweden and Finland.

6. The price of gum arabic has risen considerably in recent years. In 1970 it had almost doubled 1965 levels but by 1973 the price had more than doubled again, reaching up to £700 per ton due to drought in some producing areas and a short crop in the Sudan.

The markets for gum from the smaller suppliers, ex-French West Africa and Nigeria, are becoming more extensive and therefore less dependent on one principal purchaser. Thus, what now determines price tends to be the overall supply and demand conditions, normally the supply situation, since demand does not vary very greatly from one year to the next. At the present time (1973) there is a situation of overall shortage and so the prices of gum from different sources are all moving together in an upward direction.

7. The principal use of gum arabic is in foodstuffs, where it imparts desired qualities to foods through its influence on their viscosity, body and texture. The biggest single use is in confectionery, followed by flavours and soft drinks, pharmacy and a variety of minor outlets. On the technical side, gum arabic finds employment in adhesives, lithography, paints, inks, and various other fields.

8. The quality of gum arabic sold on the market has to be high in order to be acceptable to buyers. The major supplier of gum arabic, the Sudan, exports two grades 'Kordofan cleaned' and 'Kordofan hand-picked selected'. These appear to be model grades, whose standard other suppliers should try to achieve. In order that this high standard is reached it is essential to have efficient selection processes after the initial collection of the gum. However, it would probably be more satisfactory if those countries which do not have pure stands of *Acacia senegal* were able to ensure that collectors can distinguish between this species and those *Acacia* which provide inferior gum. Thus initial collection would be only of better quality gum. It is also essential that the trees are tapped to ensure constant quality of gum.

9. In theory, all water-soluble gums are mutually substitutable; preference is given to a particular gum on the grounds of advantage in performance or price, or occasionally on grounds of tradition alone.

Water-soluble gums comprise essentially three categories: (a) natural gums; (b) (b) modified natural gums; and (c) synthetic gums. The natural gums encompass a variety of types: namely plant exudates, of which gum arabic is one; plant extracts, of which agar, obtained from seaweeds and pectin, obtained principally from citrus fruits and apples are typical; starch derivatives and gelatin.

Modified natural gums include such materials as sodium carboxymethylcellulose, methyl cellulose, ethylmethylcellulose, and a variety of others. Synthetic gums include polyvinyl-pyrrolidone, polyvinyl-alcohol, carbopol and gums derived from ethylene oxide polymers.

The fact remains, however, that gum arabic, in many of its outlets, has a definite superiority in performance over even the most effective substitute. This is particularly so in the confectionery field, where modified starches provide the main competition. However, although inferior in performance, these modified starches are very much cheaper than gum arabic and so pose a real threat.

10. The trade structures in the importing countries are usually similar, although the demands of different users may be for different qualities and forms of gum arabic. Generally, the trade structure in the major markets is for a merchant to buy the supplies of gum arabic and either resell them in the same form or process them before resale to the ultimate users. The processing of gum arabic essentially involves two functions: cleaning and grinding. Various proportions of gum arabic are processed by merchants before reaching the ultimate users: it is estimated that at least 75 % of net imports is processed in the USA, about 13 % in the UK, and similar or smaller proportions in the other markets, with the exception of Japan, where it is very likely that a large proportion is processed before being supplied to the consuming industries.

The introduction of spray-dried gum arabic in recent years has made a large impact on the demand for gum arabic in various fields, but this is limited almost wholly to the USA.

11. Imports of gum arabic are free of duty in all countries except in India, where there is an import duty of 60 % *ad valorem* (50 % if from a British colony, and free if from the United Kingdom or Burma).

12. The present pattern of production of gum arabic has led to a situation where shortages and price increases from any one source of supply have given rise to increased interest in alternative sources of supply and an upswing in the rate of substitution of alternative materials for gum arabic. Although the first consequence of the price changes and shortages of supply appear to augur well for alternative sources of gum arabic, the second consequences of substitution poses a real threat to the future of the industry. Substitutes for gum arabic are available in many of its uses. The demand for it in the various technical fields continues to decline as more efficient and/or less expensive substitutes continue to replace gum arabic. In the flavour industry, where prospects at one time appeared good, advances in spray-dried technology coupled with fluctuating supplies and high prices for gum arabic, have meant other materials have all but supplanted the natural gum. The confectionery industry therefore remains the one major user of gum arabic. Modified starches are already being substituted for gum arabic and it is expected that the rate of substitution will increase as techniques for preparing modified starches improve and if shortages and resultant price increases continue.

Thus the gum arabic industry as a whole can be regarded as facing an uncertain situation where present suppliers are likely to lose markets unless production and marketing can be geared to overcome climatic and other external influences.

SOMMAIRE ET CONCLUSIONS

Le marché de la gomme arabique

1. La gomme arabique, plus correctement nommée suc d'acacia, provient de la résine qui s'écoule de diverses sortes d'*Acacias*. A titre commercial, deux sortes seulement sont à retenir: *L'Acacia sénégal*, qui produit la meilleure gomme et est la source principale du marché mondial; et *l'Acacia seyal*, qui produit une gomme de moins bonne qualité.

L'objet de cette étude est d'évaluer le marché actuel et les possibilités futures de la gomme arabique dans chacun des débouchés principaux des divers marchés.

2. La seule région où il existe une collection de gomme arabique d'ordre commercial sur une échelle importante se situe en Afrique au sud du désert du Sahara. Il y a trois centres importants de production; Le Soudan, le Nigéria, et les anciens territoires d'Afrique occidentale française.

La production mondiale de gomme arabique eut tendance à croître jusqu'en 1965 lorsqu'elle atteignit 67 200 tonnes. Depuis, la production a lègerèment baissé et était de 58 000 tonnes en 1971.

3. Grâce principalement à la pureté de ses pieds d'*Acacia sénégal* et donc à la facilité de sa récolte, le Soudan est le producteur principal de gomme arabique ayant fourni au cours des onze années jusqu'en 1971, entre 74 % et 88 % de la demande mondiale. Les exportations du Soudan consistent de deux sortes de gomme arabique: la gomme `hashab' ou `verek' provenant de la résine de l'*Acacia sénégal,* et la gomme `tahl' provenant de la résine de l'*Acacia seyal.* La gomme hashab représentait en moyenne 89 % de l'exportation soudanaise totale de gomme arabique de 1961 à 1971.

D'aprés une estimation des exports du Nigéria, sa contribution relative au marché mondial de gomme arabique s'élevait de 4,2 % à 9,4 % dans la période 1961 à 1971. Sa contribution moyenne annuelle relative de 8,1 % depuis 1967 est la preuve de la popularité croissante des gommes en provenance de pays autres que le Soudan.

Par tradition, on considérait que la gomme du Nigéria était de qualité inférieure à celle du Soudan, mais ceci était dû principalement à la nature moins organisée des ventes nigériennes.

Les anciens territoires français d'Afrique Occidentale (principalement le Sénégal, La Mauritanie, mais aussi le Mali, le Tchad et le Niger) ont fourni entre 1961 et 1971 en moyenne 12 % de la demande mondiale de gomme arabique, mais cette proportion a été trés variable durant cette période. Jusqu'en 1967, la France prenait en moyenne 92 % de sa demande dans ces régions, mais au cours des années suivantes, cette proportion diminua considérablement jusqu'à 60 % en 1970. Ceci suggère que d'autres grands marchés sont de plus en plus à la recherche de sources autres que le Soudan.

4. Le degré de sophistication des organisations intérieures de marketing des pays d'origine varient considérablement: en général, plus le système de marketing intérieur est organisé, plus la réputation du produit final est bonne.

Au Soudan, pendant longtemps, la vente de la gomme arabique s'est déroulée sous le contrôle bien organisé du gouvernement, culminant en Octobre 1969 par la nationalisation de l'industrie.

Dans les autres pays, la structure du marketing va d'un certain contrôle gouvernemental à l'entreprise entiérement privée. Il existe probablement une tendance croissante vers le contrôle gouvernemental qui devrait avoir pour résultat la production de gomme de meilleure qualité.

5. Les marchés principaux de gomme arabique sont les Etats Unis, la Grande Bretagne et la France. Les importations totales de ces pays sont d'environ 12 000 tonnes, 6 000 tonnes et 8 000 tonnes respectivement. A part l'Inde, qui est un cas assez spécial, l'importance d'importation en Italie, en Hollande et en Allemagne Fédérale est proche des trois premiers pays. Sept autres pays importent aussi plus de 1 000 tonnes de gomme arabique par an, ils sont le Japon, la Belgique et le Luxembourg, l.Australie, l'Afrique de Sud, le Danemark, la Suéde et la Finlande.

6. Le prix de la gomme arabique a considérablement augmenté au cours des dernières années. En 1970, il avait presque doublé depuis 1965 mais en 1973, il avait encore plus que doublé en atteignant £700 par tonne à cause de la sécheresse dans les régions productrices et une récolte faible au Soudan.

Les marchés de la gomme des petits producteurs, auparavant Afrique française de l'ouest et Nigéria, sont en cours de développement et dépendent donc moins des acheteurs principaux. Ainsi, les conditions de production et de demande ont à présent tendance à déterminer les prix, mais normalement la production comme la demande ne change guère d'une année à l'autre. A l'heure actuelle (1973), une disette générale force le prix des gommes des différentes sources à augmenter.

7. L'usage principal de la gomme arabique est en alimentation où elle donne aux produits les qualités désirées par son rôle sur leur viscosité, leur consistence et leur texture. Son usage principal est en confiserie puis dans le domaine des arômes et des boissons non alcoolisées, en pharmacie et dans divers débouchés mineurs. Du côte technique, la gomme arabique est utilisée dans les colles, en lithographie, dans les peintures, les encres et divers autres domaines.

8. La gomme arabique vendue sur le marché doit être de bonne qualité afin d'être acceptable pour les acheteurs. Le fournisseur principal de gomme arabique, le Soudan, en exporte deux qualités: `Kordofan nettoyé' et `Kordofan sélectionné manuellement'. Elles semblent être des qualités modèles dont les autres fournisseurs devraient s'efforcer d'obtenir le niveau. Afin d'obtenir cette haute qualité il est essential d'opérer un procédé de sélection efficace aprés la récolte initiale de la gomme. Cependant, il serait probablement plus utile si ces pays qui ne possèdent pas de pieds purs d'*Acacia senegal* pouvaient s'assurer que les récolteurs sont capables de distinguer entre cette sorte et celle des *Acacias* qui produisent des gommes de qualité inférieure. La récolte initiale ne consisterait ainsi que de gommes de meilleure qualité. Il est aussi essentiel que les arbres soient saignés afin d'assurer une qualité constante de la gomme.

9. Théoriquement, toutes les gommes solubles dans l'eau peuvent être substituées mutuellement; le choix d'une gomme plutôt que d'une autre s'effectue d'aprés les avantages que présentent sa performance ou son prix, ou quelques fois simplement par habitude.

Les gommes solubles dans l'eau comprennent principalement les trois catégories suivantes: (a) les gommes naturelles; (b) les gommes naturelles modifiées; (c) les gommes de synthèse. Les gommes naturelles en englobent divers types: soit, les résines de plantes (dont la gomme arabique); les extraits de plantes, par exemple l'agar provenant des algues et la pectine provenant principalement des fruits de la famille du citron et des pommes; la gélatine et les dérivés de l'amidon. Les gommes naturelles modifiées comprennent des produits tels que le carboxyméthyl de cellulose, le méthylcellulose, l'éthylméthylcellulose et divers autres matériaux. Les gommes synthétiques comprennent la pyrrolidone-polyvinylique, l'alcool polyvinylique, le carbopol et les gommes dérivées des polymères de l'oxyde d'éthylène.

La gomme arabique est cependant toujours absolument supérieure pour sa performance même aux substituants les plus efficaces. Ceci est particulièrement vrai dans le domaine de la confiserie où les amidons modifiés sont les compétiteurs principaux. Bien que de qualité inférieure, ces amidons modifiés sont cependant bien meilleur marché que la gomme arabique et sont donc trés à craindre.

10. Les structures commerciales des pays importateurs sont en général semblables bien que les besoins des divers utilisateurs soient pour des qualités et des formes différentes de gomme arabique.

En général, la structure commerciale des marchés principaux est formée d'acquéreurs qui achètent des stocks de gomme arabique, soit pour la revendre sous la même forme, soit pour la convertir avant de la revendre à l'utilisateur ultime. La conversion de la gomme arabique engendre principalement deux fonctions: le lavage et la meulage. Diverses proportions de gomme arabique sont travaillées par l'acquéreur avant d'atteindre l'utilisateur ultime: on estime qu'au moins 75 % de l'importation des USA est convertie, 13 % en Grande Bretagne, et dans des proportions semblables ou moindres sur les autres marchés, à l'exception du Japon où il est fort probable qu'une proportion importante de la gomme est transformée avant d'être vendue aux industries consommatrices.

Au cours des dernières années, l'introduction de la gomme arabique sèche pulvérisée a eu un effet important sur sa demande dans les divers domaines, mais ceci est le cas presque uniquement aux Etats Unis.

11. L'importation de gomme arabique se fait sans taxe douanière sauf en Inde où la taxe d'importation est de 60 % *ad valorem* (50 % si en provenance d'une colonie britannique et gratis en provenance de la Grande Bretagne ou de la Birmanie).

12. Le système actuel de production de gomme arabique a mené à la situation où les disettes et les augmentations de prix ont produit de l'intérêt pour des sources différentes et une croissance du taux de substitution de la gomme arabique d'autres matériaux. Bien que la première conséquence des changements de prix et des disettes semble augurer favorablement pour la recherche de sources différentes de gomme arabique, la conséquence de la substitution est une menace pour le futur de l'industrie. Les substituants de la gomme arabique sont utilisés dans beaucoup de ses usages. La demande des divers domaines techniques continue à baisser alors que des substituants plus efficaces et/ou moins chers sont en train de remplacer la gomme arabique. Dans l'industrie des arômes où à une époque les débouchés avaient semblé bons, les progrès dans le domaine de la technologie du séchage par pulvérisation, la variation de l'approvisionnement et les prix élevés de la gomme arabique ont menée la gomme naturelle à être dépassée. L'industrie de confiserie demeure donc le seul utilisateur de gomme arabique. Les amidons modifiés commencent déjà à remplacer la gomme arabique et on pense que le taux de substitution augmentera alors que leurs techniques de préparation s'amélioreront de même que si les disettes et les augmentations de prix en résultant continuent.

L'industrie de la gomme arabique peut donc être considérée comme faisant face à une situation incertaine où les fournisseurs perdront probablement leur marché à moins que la production et le marketing puisse être adapté de façon à surmonter les influences climatiques et autres.

RESUMEN Y CONCLUSIONES

El mercado de la goma arabiga

1. La goma arábiga, o goma acacia como se la denomina más correctamente, es la destilación obtenida de diversas especies de *Acacias.* Comercialmente, sólo son interesantes dos especies: *Acacia senegal,* que produce goma de la mejor clase y constituye la mayor parte del comercio mundial; y *Acacia seyal,* que produce goma de inferior calidad.

En este estudio se intenta valorar el mercado actual y perspectives futuras de la goma arábiga en cada uno de los más importantes mercados del citado producto.

2. La única zona en la que existe cultivo comercial de goma arábiga a escala importante es al Sur del desierto del Sahara en Africa. Existen tres centros importantes de producción: Sudán, Nigeria y los antiguos territorios franceses de Africa Occidental.

La producción mundial de goma arábiga fué en aumento hasta 1965, en que se alcanzó un máximo de 67.200 Tm., siendo la producción ligeramente inferior desde entonces, alcanzándose en 1971 una cifra de 58.000 Tm.

3. Principalmente como consecuencia de localizarse en el Sudán razas puras de *Acacia senegal* y la consiguiente facilidad de recogida, este país es el principal productor de goma arábiga, habiendo suministrado durante el período de once anos hasta 1971, entre el 74 % y el 88 % de las necesidades mundiales anuales. La exportación sudanesa de goma arábiga consiste en dos tipos diferentes: goma `hashab' o `verek', la cual es la destilación de la *Acacia senegal,* y la goma `tahl' que es la destilación de la *Acacia seyal.* La goma `hashab' constituyó en la década 1961–71 un promedio del 89 % del total de las exportaciones sudanesas.

La contribución relativa de las exportaciones estimadas de Nigeria al total mundial de suministro de goma arábiga, varió del 4,2 % al 9,4 % en la década 1961–71. Su contribución relativa media anual del 8,1 % del total mundial desde 1967 es evidente de un aumento de popularidad de otras fuentes de origen distintas del Sudán.

La calidad de la goma de Nigeria ha sido considerada desde siempre inferior a la del Sudán, pero ésto ha sido principalmente debido a la peor organización del comercio nigeriano.

Los antiguos territorios franceses del Africa Occidental (sobre todo Senegal y Mauritania, aunque también Malí, Chad y Níger) suministraron durante los años 1961–71 un promedio del 12 % del suministro mundial de goma arábiga, si bien esta proporción ha variado considerablemente durante el citado período. Hasta 1967 Francia logró un promedio del 92 % del suministro de esta región, pero en los siguientes años esta proporción bajó bastante, hasta situarse en un 60 % en 1970. Ello indica nuevamente que otros mercados importantes están buscando cada vez con mayor insistencia nuevas fuentes de abastecimiento distintas del Sudán.

4. La organización interna del mercado en los países de origen varía considerablemente en su nivel de sofisticación: generalmente, cuanto mayor es el nivel de organización del sistema comercial interno, tanto mayor es la reputación del producto final.

El mercado de la goma arábiga en el Sudán se ha desarrollado bajo supervisión gubernamental perfectamente regulada durante muchos años, culminando en la nacionalización de la industria en Octubre de 1969.

La estructura comercial en los otros países varía desde un nivel de control gubernamental a una situación de empresa privada en su totalidad. Existe con toda probabilidad una tendencia hacia la supervisión gubernamental, lo cual resultaría en el suministro de goma de una calidad superior.

5. Los principales mercados de goma arábiga son los Estados Unidos, el Reino Unido y Francia. Las importaciones de estos países son, respectivamente del orden de las 12.000 Tm., 6.000 Tm. y 8.000 Tm. Las importaciones de Italia, Holanda y la República Federal de Alemania siguen en importancia, y aparte de la India, que es un caso especial, existen otros siete países que importan con regularidad más de 1.000 Tm. de goma arábiga al año; éstos son: Japón, Bélgica-Luxemburgo, Australia, República Sudafricana, Dinamarca, Suecia y Finlandia.

6. El precio de la goma arábiga ha aumentado considerablemente durante los últimos años. En 1970 llegó a ser el doble que en 1965; sin embargo, en 1973 volvió a doblarse alcanzando las £700.–por Tm., debido a la sequia habida en algunas zonas productoras y a la escasa cosecha del Sudán.

El mercado de goma para los abastecedores menos importantes del Africa Occidental Francesa y Nigeria se está ampliando gradualmente, por lo que ya no depende tanto de un único comprador principal. De esta forma, el determinante del precio viene dado cada vez más por las condiciones de oferta y demanda globales, dependiendo sobre todo de la oferta, ya que la demanda no varía mucho de un año a otro. En las actuales circunstancias, en 1973, existe una situación de escasez general, por lo que los precios de goma procedentes de diferentes fuentes de origen están experimentando un incremento general.

7. La principal aplicación de la goma arábiga se encuentra en la industria alimenticia, dando a algunos productos cualidades apetecibles por su influencia en la viscosidad, cuerpo y textura. Se emplea sobre todo en confitería, condimentación y bebidas no alcohólicas, farmacia y otras aplicaciones diversas. En el campo técnico, se usa la goma arábiga en adhesivos, litografla, pinturas, tintas y otros campos.

8. La calidad de la goma arábiga vendida en el mercado debe ser elevada con objeto de merecer la aceptación del comprador. El principal suministrador de goma arábiga, Sudán, exporta dos tipos de goma: `Kordofan limpia' y `Kordofan seleccionada a mano'. Se consideran tipos modelo, cuyo standard debería ser alcanzado por otros abastecedores. Con objeto de obtener este elevado grado, es esencial el proceso de selección después de la recogida inicial de la goma. Sin embargo, sería mucho más satisfactorio que en los países donde no hay sedimentos puros de *Acacia senegal* se pudiera lograr que los cosechadores supieran distinguir entre esta especie y las de otras *Acacias* de inferior calidad. Así se conseguiría una mejor calidad de goma durante la recogida inicial. Tambien es esencial que los árboles estén sangrados si se desea conseguir una calidad constante de goma.

9. En teoría, todas las gomas solubles en agua son mutuamente reemplazables; la preferencia de una goma a otra se basa en su aplicación o precio, o en algunas ocasiones únicamente en tradición.

Las gomas solubles en agua se dividen en tres categorías principales: a) gomas naturales. b) gomas naturales modificadas. c) gomas sintéticas. Las gomas naturales abarcan gran diversidad de tipos, por ejemplo, destilación de plantas (de la que la goma arábiga forma parte), extractos de planta, como el agar, que se obtiene de algas y de la pectina que se obtiene principalmente de los cítricos y de las manzanas; también la gelatina y derivados del almidón.

Las gomas naturales modificadas poseen diversas materias como sodio, carboximetilcelulosa, metilcelulosa, etilmetilcelulosa y otros varios. Las gomas sintéticas poseen polivinil-pirrolidona, alcohol polivinílico, carbopol y gomas derivadas de polímeros de óxido de etileno.

La realidad es que la goma arábiga, a través de sus aplicaciones, ostenta una gran superioridad sobre cualquier sustituto, sobre todo en el campo de la confitería, en el que la principal competencia viene dada por los almidones modificados. No obstante, aunque sus resultados son inferiores, estos almidones modificados son mucho más baratos que la goma arábiga, por lo que significan una amenaza seria.

10. Las estructuras comerciales de los países importadores son generalmente análogas, si bien la demanda de distintos consumidores varía en cuanto a calidades y formas de goma arábiga.

Generalmente, la estructura comercial en los mercados importantes es la siguiente: Un comerciante compra el suministro de goma arábiga y la vende en las mismas condiciones o la somete a diferentes procesos antes de venderla a los consumidores definitivos. La elaboración de la goma arábiga comprende generalmente dos funciones: limpiado y molienda. Una proporción determinada de goma arábiga es elaborada por los comerciantes antes de llegar a los últimos consumidores: se estima que al menos el 75 % de las importaciones netas se elaboran en los Estados Unidos, cerca de un 13 % en el Reino Unido, y cantidades similares o menores en otros mercados, a excepción del Japón, donde con toda probabilidad se elabora una gran proporción antes de abastecer a las industrias consumidoras.

La introducción de goma seca al spray desde hace algunos años ha significado un gran aumento en la demanda de goma arábiga en diversos campos, aunque ésto se limita casi en su totalidad a los Estados Unidos.

11. Las importaciones de goma arábiga no están gravadas con arancel alguno, excepto en la India, donde existe un arancel del 60 % *ad valorem* (si se trata de una colonia británica es del 50 %, siendo libre de arancel si procede del Reino Unido o Burma).

12. El sistema actual de producción de goma arábiga ha creado una situación en la que la escasez e incrementos en precio por parte de cualquier punto de origen, hace que aumente el interés en encontrar distintas fuentes de suministro y origina un aumento en el nivel de sustitución de la goma arábiga por materias alternativas. Aunque la primera consecuencia de los cambios de precio y escasez de oferta hace augurar buenas perspectivas a las fuentes alternativas de goma arábiga, la segunda consecuencia de esta sustitución origina una amenaza seria sobre el futuro de la industria. Se pueden obtener sustitutos de goma arábiga en muchos de sus usos. Su demanda en diversos campos técnicos continúa decreciendo a medida que sustitutos más eficaces y menos caros continúan reemplazando a la goma arábiga. En la industria del condimento, en la cual las perspectivas parecían buenas hace algún tiempo, los adelantes en la técnica del secado a spray junto con fluctuaciones en la oferta y precios elevados de la goma arábiga, han originado la aparición de otros productos que han sistituído a la goma natural por completo. La industria de la confitería permanece, por tanto, como una de las principales consumidoras de goma arábiga. En la actualidad el almidón modificado está ya sustituyendo a la goma arábiga y es de esperar que este nivel de sustitución aumentará a medida que las técnicas de preparación de almidón modificado se perfeccionan y la escasez y aumentos en precio continúan.

Por consiguiente, se puede considerar que la industria de la goma arábiga en general está atravesando una situación incierta en la cual los abastecedores actuales perderán mercados con toda probabilidad a menos que la producción y comercialización se planifique para superar influencias climáticas adversas y otras de tipo externo.

Part I

Introduction

Gum arabic, or gum acacia as it is more correctly termed, is the exudate obtained from various species of the *Acacia* genus. About 500 species of *Acacia* are distributed over tropical and sub-tropical areas of Africa, India, Australia and America but, for commercial purposes, only two of the species are particularly significant: *Acacia senegal* (or *A.verek),* which produces the best type of gum, provides for the vast bulk of world trade; and *Acacia seyal*, which produces a lower grade of gum, provides for a minor part of world trade. Small quantities of gum are collected from many other species but, having inferior properties to those from the *senegal* and *seyal* species, such gums are not acceptable in the main markets.

Gum arabic is unique in that sizeable quantities of it are produced only when the trees have been wounded either accidentally or deliberately: trees grown under adverse conditions of high elevation, excessive heat, and scarcity of moisture produce larger quantities of gum. The yield of gum can be further increased with deliberate injury to the tree, by stripping away the bark. Although one school of thought still maintains that the production of gum is a natural metabolic process, the general consensus of opinion is that the gum is produced as a protective measure by the tree, following bacterial or fungal infection.

Gum arabic is a commodity which has figured in world trade since earliest times. As with many such natural products originating in distant lands, gum arabic took the name of the country of last despatch prior to reaching the main markets.

The nature of the trade in gum arabic, together with its unique combination of properties, resulted in a wide variety of applications in various industries. However, the use of gum arabic in several fields is now largely traditional and, in quantitative terms, relatively insignificant. Some new uses have been found for it but, at the present time, the situation appears to be very much in the balance: some form of substitute, synthetic or otherwise, is available in virtually all the applications of gum arabic. In some uses, a preferred substitute has almost totally eliminated the need for gum arabic, while in other outlets gum arabic still has definite preference. This study attempts to examine the situation in relation to each major outlet for gum arabic, to estimate the important trends, and to give some idea of the overall prospects for gum arabic in future years.

Part II

Production

General

The only area where there is commercial collection of gum arabic on a substantial scale is that part of Africa south of the Sahara desert, this area being the principal location of the *senegal* and *seyal* species. In present political terms this area comprises those countries lying between Ethiopia and Northern Somalia in the east and Senegal and Mauritania in the west. These countries account for virtually all commercial collection of gum arabic, apart from that gathered in Tanzania, which has a similar environment to the area further north; Iran, whose gum may not in fact come from a species of acacia; and India, which has a small production of an inferior gum, almost all of which is consumed domestically.

There are no complete figures available for production of gum arabic but, since virtually all of the supplies are exported, export totals provide an extremely close approximation to overall production totals. However, the export statistics are not particularly accurate in several instances, and various compromises have had to be resorted to in an attempt to arrive at realistic export totals. These will be explained as the exports from each region are considered in turn.

World production totals are estimated in Table 1 of the statistical appendix on the basis of the aggregated exports of Sudan, the ex-French territories in West Africa, Nigeria and Tanzania. As the figures illustrate, world production has risen over the years, although it appears to have stagnated since 1965. Between 1961 and 1965 it rose from 64 000 tons to 67 000 tons. After 1965 production declined, albeit gradually and in 1971 was estimated at 58 000 tons.

Sudan

Largely as a result of its possession of pure stands of *Acacia senegal* and the consequent ease of collection, Sudan is the dominant producer of gum arabic, supplying in the period 1961 to 1971, between 74 % and 88 % of annual world requirements. Since 1968 Sudanese exports have accounted for a decreasing proportion of world requirements her share falling from 82 % in 1968 to 74 % in 1971. Apart from the natural forest stands of *Acacia senegal* the species also forms part of the shifting 'bush fallow system' of agriculture, and trees are allowed to regenerate in stands locally known as 'gum gardens'. Plantations of *Acacia senegal* are also being raised on Government land and private holdings. Sudan is also the only country where gum arabic is a significant contributor to foreign exchange earnings.

Sudanese exports of gum arabic consist essentially of two types: gum 'Hashab' or 'verek' (known as Kordofan gum arabic because a part of the supplies come from the Kordofan province in the Sudan) which is the exudate from *Acacia senegal*, and gum 'tahl', which is the exudate from *Acacia seyal.* Gum hashab accounted for an average of 89 % of total Sudanese exports of gum arabic over the period 1961–1971. Exports of gum hashab by country of destination are listed in Table 2 of the Appendix.

The long-run trend in exports of Sudanese gum hashab has shown considerable growth. From a pre-war peak of 24 000 tons in 1938, exports fell off during the Second World War but recovered to above the 1938 level immediately afterwards. They increased rapidly to an average of about 38 000 tons per annum between 1950 and 1954. Further expansion followed, though at a somewhat slower rate, to an average of 42 000 tons per annum in the years 1953–57 and to 46 250 tons in the years 1956–1960. Table 1 shows that during the early 1960s, up until 1963 exports averaged 42 600 tons. However, after 1963 exports again rose reaching an all time peak of 52 600 tons in 1965 with an average figure of 44 000 tons in the years 1966–1971. In fact since 1966 exports have steadily declined, falling from 50 600 tons in 1966 to 38 000 tons in 1971 and according to trade sources were even lower in 1972 at 35 000 tons. Exports have declined to these levels because of a succession of poor crops, added to which have been the drought conditions spreading through those countries south of the Sahara into the Western province of Sudan.

There is also an increasing tendency for dealers in gum arabic in the importing countries to look elsewhere for their supplies and to promote increases in the production of the less significant suppliers (see Part VII). The statistics do suggest that the Sudan has a tendency to provide for a diminishing proportion of world requirements of gum arabic, although care must be taken in assuming a trend from the recorded figures for only a few years. In the period 1961–71 Sudan supplied an annual average of 81.5 % of world requirements of gum arabic. Within this period, a peak was reached in 1964 when the proportion was 88 %. An overall decline, to 74 % in the year 1971, followed.

The gum is collected on a more systematic basis in the Sudan then elsewhere, much of it coming from ‘cultivated’ trees. These are ‘cultivated’ in the sense that the stands of trees are continually restocked and are regularly tapped, i.e. wounds are cut in the trees to encourage exudation. There is also a great deal of wild gum collected on a more casual basis, the amount depending on the relative attractiveness of other crops to the collectors, and particularly on the success of the local sorghum crop, durra.

Grades

Until the latter part of 1969, gum hashab was divided into the following grades for export purposes:– natural, cleaned, cleaned and sifted, hand-picked selected, bleach and dust. When the marketing system was re-organised in 1969, the cleaned and sifted and bleached grades were abolished.

Significant quantities of the cleaned and sifted grade had been sold prior to 1969, particularly to the USA. This grade differed from the cleaned grade in that it was passed over a mesh sieve of a particular size in order to get rid of the smallest lumps and any remaining sand and dust. The bleached grade also enjoyed a small steady demand. In order to achieve the virtually white or colourless appearance of this grade, the gum was exposed to the sun for several weeks during the hottest part of the year, reducing the moisture content and so imparting a uniform light colour to the gum.

The grades of gum hashab which have been available since 1969 are:–

(a) ‘Natural’ This grade consists of gum arabic as it is picked from the tree, containing all the associated impurities. The gum is not normally exported in this form because importing countries do not have the skilled cheap labour required for sorting and grading the gum.

(b) ‘Cleaned’ The bulk of the gum is exported in this grade. Impurities such as bark, twigs and bits of other varieties of gums are removed, together with the smaller fragments and ‘dust’ of the gum, which is sold as a separate grade.

(c) 'Hand-picked selected' As the term suggests, small quantities are specially selected by hand-picking and consist of only the better pieces of gum, essentially the larger pieces of uniform pale colour. There is a fairly stable demand for this grade, some 12 000 tons per annum.

(d) 'Dust' This is the waste from other grades, particularly the 'cleaned and sifted' grade. Exports of this grade are not insignificant, ranging from 375 to 777 tons annually in the years 1967–1971 and averaging 415 tons over the period 1961–1971. Although with the reorganisation of the marketing system and the abolition of the 'cleaned and sifted' grade supplies of 'dust' were expected to be considerably less than before, export figures show no real drop in supplies.

Sudanese or Kordofan gum arabic is generallly accepted as being the highest quality gum arabic in the world and the standards of other gums from alternative sources are set with reference to it.

Gum tahl

There appears to be some difference of opinion in the trade as to what exactly constitutes gum tahl: some merchants appear to believe that tahl is merely the smaller fragments and dust of the gum hashab. This is not the case. Gum tahl is the exudate from *Acacia seyal*: it is an inferior type of gum, its main drawback being that it is less soluble than the exudate from *Acacia senegal.* There is a steady demand for gum tahl, averaging 4 726 tons annually over the period 1961–71, but its uses are limited and it is unlikely that demand will increase; on the other hand, there are no signs as yet of a decline in demand, which has been expected for several years. *Acacia seyal* trees are not tapped, only the natural exudates being collected by the local population. Besides tahl, this gum is known by a variety of pseudonyms, such as talca, talha, talki or suakim gum.

Nigeria

There appears to have been relatively little interest in gum arabic from Nigeria until the war years, when a stimulus was given to production. Exports reached 1 000 tons in the early 1950s and, according to the official Nigerian export figures fluctuated around 1 600 tons between 1955 and 1959. In 1960, a record export was recorded of over 4 800 tons, since when exports have fluctuated around a lower level of some 2 600 tons before rising again to 4 400 tons in 1967. This higher level of exports continued until 1970, when 4 900 tons of gum were exported, but in 1971 exports reverted to a lower level of 2 500 tons.

However, it seems fairly certain that these figures are considerably on the low side. In order to give a better estimate of the Nigerian exports of gum arabic, imports from Nigeria into the main markets have been aggregated. Table 1 shows both recorded exports from Nigeria and imputed exports.

The imputed exports are considered to give a more accurate picture of Nigerian exports. Average annual exports were 3 500 tons between 1961 and 1966. After 1966 exports rose to a peak of 5 900 tons in 1969. Exports in 1970 and 1971 were 5 000 tons and 4 400 tons respectively.

On the basis of the imputed exports from Nigeria, its relative contribution to the world supplies of gum arabic has ranged between 4.2 % and 9.4 % in the years 1961 to 1971. Since 1967 annual exports from Nigeria have averaged 8.1 % of world indigenous exports. This rise in Nigeria's share of the world market is evidence of the increasing popularity of gum from sources other than the Sudan.

Grades

Three general classes of Nigerian gum arabic are recognised.

(a) 'Falli' or Kolkol' gum, the exudate from *Acacia senegal.* This gum is of good appearance and quality, and is comparable with Kordofan gum, although it has been reported to produce a slightly darker colour in solution. The bulk of Nigerian exports of gum arabic are of this type.

(b) 'Marrua' gum, derived from *Acacia seyal* or *Acacia xanthophloea,* is an inferior gum which normally has a yellowish or reddish colour. It is more or less equivalent to the Sudanese tahl gum.

(c) 'Mumuye' gum is not strictly speaking a gum arabic since it is derived not from a species of acacia, but from the *Combretum* genera of plants. It is mentioned because bits of it frequently appear in lots of gum arabic. Mumuye gum is dark and is normally found in large lumps or masses.

The quality of Nigerian gum arabic has traditionally been considered as inferior to that of the Sudan, but this has largely been attributed to the way in which the Nigerian gum arabic trade is organised. Suggestions that Nigerian gum arabic is necessarily of a darker colour or less soluble than Sudanese supplies are not borne out by contact with those who make use of both, although it is possible that Nigerian gum tends to be slightly more viscous and stringy. If the Nigerian gum is carefully collected and graded for export, it should be of comparable quality to that of the Sudan.

Because of the looser trading structure in Nigeria, there are as yet no official grades of gum. The larger shipping merchants grade the gum according to their own standards, say No 1 and No 2. These grades have developed a reputation in the importing countries, where they are accepted as standard. The No 1 grades of the larger companies tend to be comparable to the Kordofan 'cleaned' grade.

Former French Territories in West Africa

In terms of commercial significance, the principal countries included under this heading are Senegal and Mauritania; other significant suppliers are Mali, Chad and Niger, and occasional shipments have been recorded fron Congo (Brazzaville) and Gabon. For two important reasons it is convenient to consider these countries under one heading when referring to their role as suppliers of gum arabic.

One reason is that, until 1961, it was not possible to separate the export statistics for gum arabic. The export figures are also sometimes liable to error. 'True' exports have therefore been estimated by aggregating the imports into the main markets. Many countries, however, do not record imports from the above countries separately, but under a communal heading such as 'Senegal, etc'.

The more basic reason, which is presumably why it was found difficult to list exports or imports separately, is that much of the gum in this region is collected in the sparsely populated border lands between the countries, where no effective customs control exists. Consequently, the gum tends to appear in the markets of that country which has the most favourable regulations and prices pertaining at the time, provided the distance to be covered does not completely offset such advantages.

Total recorded exports for the region tend to be less than aggregate recorded imports, but the difference is extreme only in one year, 1963, when recorded exports amounted to only 1 893 tons. However, the variations are significant and the imputed exports show a more accurate picture of the magnitude of exports from these countries. Both recorded and imputed exports are shown in Table 1. Between 1961 and 1966 annual average exports on an imputed basis for the whole of the ex-French territories, were 4 200 tons. A very sharp rise occurred in 1967, with exports estimated at 8 800 tons. The 1968 figure was considerably lower, at 6 000 tons, but still well above the previous years' average. In 1969 exports resumed the upward trend which continued into 1970 when imports reached a peak of 10 500 tons. The figures therefore suggest that exports from this region have followed a rising trend, again prompted by the desire of merchants and some large users to lessen their dependence on Sudanese supplies of gum arabic. The relative contribution of the ex-French territories to world supply has varied over the period 1961–71. Between 1961 and 1965 their share rose from 8.4 % to 14.3 %. For the next two years, however, the contribution fell but after 1968 their share of world imports steadily increased to 18.0 % in 1971. Over the entire period exports from these countries averaged 12 % of world supplies.

For the reasons mentioned above, the exports recorded from the individual countries should be treated with some caution, but such figures should at least be indicative of the general trend. Senegal has traditionally provided the bulk of the of the supplies and in 1970 recorded exports reached a peak of 9 415 tons. Mauritania has established a position of some importance in recent years with recorded annual exports rising steadily from 2 200 tons to 4 200 tons in the years 1964–68. Annual exports from Mali fluctuated over the period under review, varying between 110 tons and 800 tons. Recorded exports from Niger varied between 134 tons and 261 tons in the years 1961–65. Recorded exports are not available after 1965. During 1972 and 1973 however, supplies from these countries have become unobtainable due to the severe drought in the belt of land south of the Sahara. The long term effects of this may mean production in these areas will be severely curtailed.

Grades

Virtually all supplies of gum arabic emanating from these countries are collected from *Acacia senegal,* and again the quality is comparable to that of the Sudan, provided the gum is carefully collected and sorted. In fact, much of the more precise grading of the gum from this region still takes place following import into France, at Bordeaux, the main trading centre in gum arabic from the ex–French colonies. In the countries of origin, particularly Senegal, the gum is available in two main qualities: gum *bas de fleuve* and gum Ferlo. Gum *bas de fleuve* is the lighter colour of the two and therefore considered superior to gum Ferlo and of comparable quality to Kordofan gum. It has been suggested that gum from this region is more viscous but much less adhesive than Kordofan. This may or may not be true, but the general opinion in the trade is that the gum is of good quality and can be substituted for Kordofan in almost all uses.

Throughout most of the 1960s France imported an average of 92 % of the supplies from this region. However, after 1967 this proportion declined considerably, to an average of 61 %. This again suggests that other large markets are increasingly seeking alternative sources of supply to the Sudan.

In Bordeaux, the gum is graded into the following categories:

(a) gomme blanche – colourless and presumably comparable to kordofan 'hand picked selected';

(b) gomme petit blanche – small pieces of the same;

(c) gomme blonde – a darker colour;

(d) gomme petit blonde – small pieces of the same;

(e) gomme vermicelle – a whitish to pale yellow gum;

(f) gomme fabrique – the rejected pieces of gum (usually because of their dark colour.)

However, the trend away from such a strong reliance on France as the principal market for their supplies of gum arabic suggests that either the countries of origin are grading their own gum prior to export, or that supplies are being delivered to other markets in a fairly crude state. No definite knowledge is available on this point, but the former alternative seems more likely.

Tanzania

Collection of gum in Tanzania is of a much less systematic nature than elsewhere, depending to a large extent on the progress of the collectors' other crops. It is also on a definite downward trend. During the 1960s, quantities of up to 2 000 tons were exported annually, but by 1957–59 these had dropped to an average of 1 000 tons per annum. Between 1961 and 1971 supplies fluctuated but the underlying trend was still downward and quantities exported varied between 188 tons and 802 tons in the period. It seems clear that there is no future for Tanzanian gum arabic and that this particular industry will soon become extinct. The reason for this is essentially the poor quality of Tanzanian gum arabic. The bulk of it is derived, not from the two major *Acacia* species, but from *Acacia drepanolobium.* The end product is similar to tahl gum, but apparently considerably less viscous. No grading of the gum is carried out in Tanzania at all, although some is traditionally exported to Bombay in India, where it is sorted and graded and some of it subsequently re-exported.

Others

Iran has supplied considerable quantities of gum in the past, amounting to 2 – 3 000 tons, annually, but in more recent years these supplies have become increasingly insignificant. This gum, known as Persian gum or gum shiraz, may not in fact be an exudate from a species of *Acacia.* Gum shiraz is not wholly soluble in water and, probably because of this major drawback, has lost most of its market in the last few years. The demand for this gum, which has already dropped to a few hundred tons annually, will almost certainly continue to fall. Small quantities of gum arabic have been exported by several other countries, both in West Africa and in the Middle East, but there is no evidence to suggest that any of these smaller suppliers are in the process of expanding capacity to become a significant factor in the overall supply situation.

Part III

Internal marketing organisations

General

The internal marketing organisations in the countries of origin vary considerably in their degree of sophistication: generally, the greater the degree of organisation of the internal marketing system, the higher the reputation of the final product. It is true that gum exudates from the *Acacia senegal* species in different geographical locations do have minor variations in properties and structure and therefore can be considered of different quality for certain purposes; but the majority of complaints concerning poor quality gum arabic refer solely to the fact that many batches include inferior pieces of gum, i.e., gum from a species other than *Acacia senegal*, or pieces which are too small or too dark coloured. These faults can be remedied by improvements in the internal marketing systems.

Sudan

The marketing of gum arabic in the Sudan is conducted under well-regulated government supervision, and has been so for some time. In 1922 a system of government-supervised public auctions was introduced in several regional centres, to which the local collectors brought their supplies of gum arabic at certain appointed times during and after the collecting season, which takes place in the dry season (usually from October to May or June). At these auctions the gum was sold to dealers who transported it to Khartoum, where it was graded and subsequently exported.

This well-organised system continued more or less unchanged until 1962, when the government took steps to stabilise the price of gum arabic. Floor prices were set at the public auctions and a Gum Equalisation Association (later renamed the Gum Traders' Association) composed of gum exporters was formed. The purpose of the Association was to buy any gum not already bought at the fixed floor prices, and to sell it later to exporters when the Association, in consultation with the government, considered it timely. Thus, by 1962, the government already had some influence over the Sudanese gum arabic trade.

The next major step was taken in October 1969, when a company, the Gum Arabic Company Ltd, was established and given a statutory monopoly of the gum arabic trade. The shares of this company were allocated to the private exporters, the government and the public in the ratio, 4:3:3. The marketing chain is now one whereby producers transport the gum to nearby village markets, where it is stored by gum buyers until such time as sufficient quantities are collected for transportation to the larger town markets. These latter markets operate on a minimum fixed price system below which no gum can be sold. Buyers in the town markets then take the gum to be cleaned, graded and packed according to certain specifications. The packed gum is then transported from these production centres to Port Sudan where it is sold to the Gum Arabic Company Ltd, the sole exporter from the Sudan. Following the nationalisation of the industry, the decision was taken to simplify the marketing process and to sell gum Kordofan in only two grades, cleaned and hand-picked selected. Some of the natural grade is still being offered but this will cease to be so in the future. The simplifying of the grading system is a sensible move; the only possible difficulty is that the USA, which traditionally bought large quantities of the cleaned and sifted grade, might tend to look elsewhere for supplies now that this grade is abolished. However, since the rationalisation of the grading system, the quality of the cleaned Kordofan has improved to such a degree that it is difficult at times to differentiate between the cleaned and the hand-picked selected grades.

Nigeria

The internal marketing structure for gum arabic in Nigeria is conducted wholly under conditions of private enterprise. The bulk of the collection comes from Bornu province, where almost pure stands of *Acacia senegal* are found. Tapping is practised and the collecting season normally runs from January or February to the beginning of the rains in the late spring. The gum is collected by local villagers and usually taken to two upcountry trading centres, Maiduguri and Enguru, where it is bought by merchants who clean the gum and sell it to two or three large expatriate British companies who are the major exporters of Nigerian gum arabic. It is often the case that the large exporters also have agents upcountry to buy in the local markets. Each of the major exporting companies grades its own gum. Typical grades are:

No 1 grade — this grade constitutes the bulk of Nigerian supplies and is of a quality comparable to cleaned Kordofan;

No 2 grade — this grade consists of small chippings of gum, of a quality similar to No 1;

No 3 grade — a dark red gum.

These grades are those of a large British-based company which has traditionally set the standard for Nigerian gum on the international market.

As purchasers of gum arabic continue to encourage alternative sources of supply to the Sudan, a greater interest is being shown in the marketing of Nigerian gum. More foreign merchanting firms are successfully bidding for supplies, and local Nigerian merchants are also beginning to make their presence felt in the export trade. The difficulty is that without a long-standing reputation, these local Nigerian concerns must sell their gum on a sample basis and, even if the sample is of good quality, importing merchants are wary of changing their supplier, particularly to an unknown local concern.

Ex-French Territories

The organisation of the marketing structures vary from country to country, but there is a general tendency towards increased government supervision and control. This influence has resulted in an improved quality of gum but because of the transport of gum across borders, regulations have often been difficult to enforce.

Senegal

The gum arabic trade in Senegal is conducted by private companies. It is still very much in the hands of expatriate French trading firms, old-established concerns which buy the gum from the local villagers and traditionally sort it into two main qualities before transporting it to France. But with the decreasing dependence on France as the main market, more gum is almost certainly being more precisely graded in Senegal prior to export.

Mauritania

Mauritania is a large producer of gum arabic, but much of its production is ultimately exported via Senegal, although probably less so than formerly. There exists in fact a statutory monopoly over the Mauritanian gum arabic trade, but it is impossible to enforce this monopoly when the gum can be so easily transported across the border and sold in the local markets of northern Senegal. As a result, the private merchants still play a large part in the Mauritanian trade.

Chad

In Chad, one firm has a statutory monopoly under which it is entitled to buy all supplies of gum arabic from the local villagers and to act as the sole exporter. This company grades the gum, essentially into one grade which is equivalent to Kordofan cleaned.

Mali

Theoretically, one firm has a statutory monopoly over the gum arabic trade, but at the present time competition is still tolerated from two or three private concerns. Good-quality gum from Mali is very similar to that of Nigeria.

Niger

Again, a statutory monopoly officially controls the trade in gum arabic. But Niger is a landlocked country and the bulk of her gum is exported through Lagos in Nigeria. Under such a system, it is very difficult for the statutory monopoly to enforce its rights.

Conclusion

The trend in the ex-French territories is one of increasing efforts to ensure that the gum arabic is of comparable quality to that of the Sudan. The industries are becoming more efficiently organised, although the practice of tapping became prevalent only in recent years. These efforts are meeting with a considerable degree of success.

Part IV

Prices

Current prices for gum arabic are quoted in several publications, both in the United Kingdom and elsewhere. Since these prices refer to small deals (except after October 1969, when the monopoly company in the Sudan set a price at which it was willing to sell to anyone, provided the quantity purchased was not less than ten tons) they cannot be regarded as being a strictly accurate reflection of the level of world prices, but they do indicate the general trends. The price series in the various publications show no significant divergences. The series used in this report is from *The Public Ledger* and is given in Table 3 of the appendix. The only price series available is for Sudanese Kordofan.

The accompanying graph (Figure I) illustrates the price movements of the Kordofan cleaned grade of Sudanese gum arabic, which is the norm for all dealings in gum arabic on the international market. The price of this grade was fairly stable over the years 1961–65, rising gradually from around £130 per ton at the end of 1961 to around £150 per ton by the end of 1965 the price then rose sharply to £227 per ton in the second quarter of 1967 and further increased, amid fluctuations, to some £250 per ton by the end of 1969 (much of this being accounted for by the British devaluation in November 1967). In 1970 at least two official increases took place. The Gum Arabic Company Ltd, the official Sudanese monopoly, raised the price of Kordofan cleaned to £268 per ton, cif, on 24 February and to £275 on 21 March. By mid-1972 prices had risen to almost £300 per ton but by mid-1973 the situation had changed dramatically because of the drought south of the Sahara. Trade sources reported that gum from the ex-French territories in Africa and from Nigeria was virtually unobtainable. This also indirectly affected supplies of Sudanese gum which were already less than normal because of poor crops and prices of gum were stated to be in excess of £500 per ton. New crop arrivals later in the year were expected to cause a lowering of previous months' artificial prices and it was thought prices would be in the region of £350–£400 per ton.

Thus the price of gum arabic has risen considerably in recent years; indeed it has doubled since 1965. The demand for the gum has been affected detrimentally, with many firms going over to the use of a variety of substitutes. An attempt is made to estimate to what extent this has occurred in Part IX of this report.

The relationship between the prices of the various grades of Sudanese gum arabic has traditionally been constant at the following differentials, assuming the price of Kordofan cleaned to be £x per ton:

1.	natural:	£x - 3 per ton
2.	cleaned and sifted:	£x + 3½ ,, ,,
3.	hand-picked selected:	£x + 14 ,, ,,

There are no prices recorded in importing countries for gum tahl, but the Sudanese export figures give a fairly accurate indication. During the period 1957–67, the unit value of exports of gum tahl was around £60 per ton. In 1968 this figure rose sharply to £79 per ton and continued rising, reaching £88 per ton in 1971. This suggests that the price of gum tahl has followed the price of Kordofan gum although perhaps with a certain lag.

Other sources of information on prices are the trade returns of the various countries, from which the average unit value of exports or imports can be calculated. These statistics are illustrated in, Figures II (a) and (b) of Appendix B.

These diagrams indicate that there is no single trend in prices applicable to all sources and markets but that, as might be expected, the price of Sudanese gum arabic has a dominant influence on general price trends. The prices derived from Sudanese exports of gum hashab and those derived from most counties' import statistics show a strong tendency to move together. The unit values of US imports have a particularly strong correlation with the unit values of Sudanese exports, since the USA imports almost all of her supplies of gum arabic from the Sudan. The unit values of UK imports generally follow those of Sudanese exports, and deviations from this trend can largely be explained by the effect of price changes of Nigerian gum arabic. The position is similar with the French import statistics.

The price series derived from French imports and Senegalese exports follow each other very closely, since France purchases the bulk of ex-French West African supplies. Series based on exports from Sudan and Senegal are reasonably similar and between 1961 and 1969 Senegal prices roughly followed the Sudanese trend. Variations from this have occurred at certain times, such as in 1962, 1965 and 1966 (particularly in 1966 when the price of Senegal gum fell considerably while the Sudanese remained fairly stable). After 1969 the price of Sudanese gum levelled off whilst Senegal prices continued to rise quite steeply. Thus by 1970 the price differential between Sudanese and Senegalese gum had narrowed considerably.

The Nigerian figures vary more widely from the norm set by the Sudanese unit values than the Senegalese values discussed above. Between 1961 and 1965 the differential between Nigerian and Sudanese values widened so that Nigerian values were some £35 below Sudanese levels. Then after a short period when Nigerian values recovered, the differential continued to widen and by 1971 it was some £90.

Tanzanian prices are considerably lower than the others. There was a general tendency to follow the Sudanese price trend, except in the years 1967–68, when the Tanzanian prices moved in the opposite direction to the majority.

It has been suggested that in most years prices reflect the varying supply conditions in the producing countries, but that in years of particularly high demand all prices tend to move together. This argument is borne out only very crudely by the statistics. It is certainly true that in general prices reflect the supply conditions, but there is an increasing tendency for these to be the overall supply conditions rather than those prevailing within the specific counties, indicating that the overall market for gum arabic is becoming more uniform.

Therefore it is less likely that individual supply conditions alone will greatly affect the prices of the respective supplies. The markets for gum from the smaller suppliers, ex-French West Africa and Nigeria, are becoming more extensive and therefore less dependent on one principal purchaser. (Large purchasers now realise, partly because of the improvement in quality of supplies from sources other than the Sudan, that the better-quality gum from any source is much the same and so they are prepared to buy in the cheapest markets.) Thus, what determines price is the overall supply and demand conditions, normally the supply situation since demand does not vary very greatly from one year to the next.

Of course, Sudan, with her very large share of the market, can exploit this dominant position by setting prices artificially high. If this happens, then the prices of supplies from other sources are bid up to a point in the vicinity of the Sudanese price. If this were true, then the artificially high price would probably result in some unsold stocks in the Sudan. It is possible that this state of affairs did exist in the years 1965–68, when prices rose considerably and there was probably a fairly large stock in the Sudan, but the shortages in the last two seasons have wiped out these stocks completely and the present high prices almost certainly reflect the true supply and demand conditions.

Despite the shortage, however, gum from Nigeria and the ex-French territories still sells at less than comparable Sudanese gum, the present discount being around £5 to £10 per ton. This price differential is very much smaller than formerly, although it can be seen from the graph that at other specific times in the past the price of either Nigerian or Senegalese gum has approached that of the Sudan. The implication is that quality improvements have not in fact had very much effect on the price and that a condition of overall shortage has been the prime mover in reducing the price differentials between gums from different sources, together with the resentment caused by the nationalisation of the Sudanese industry. At the beginning of 1969–70 Senegal gum was selling for as much as £40 per ton less than Kordofan but this differential had fallen to £10 per ton by Spring 1970. Had normal supply conditions prevailed in 1973 prices were expected to be some £10–£15 per ton less than Sudanese gum.

Part V

Uses

Gums in general are used in the manufacture of a great number of products and for many of them there is no strong preference for one gum over another, a great deal of substitution in either direction being possible. The choice of gum in each particular field depends largely on slight advantages in performance, on tradition and on price.

Gum arabic is unique among the natural hydrocolloids because of its extremely high solubility in water. It can form a solution in water at concentrations up to 50 %, whereas most other gums cannot be dissolved in water at concentrations of more than 5 % or so because of their very high viscosities. This ability of gum arabic to form highly concentrated solutions gives it excellent stabilising and emulsifying properties when combined with large amounts of insoluble materials. These properties are responsible for much of the use of gum arabic. Added advantages are that gum arabic is non-toxic, odourless, colourless and tasteless, and does not affect the colour, odour or taste of other materials with which it comes in contact.

The principal use of gum arabic is in foodstuffs (the relative quantitative importance of the different outlets is discussed later): it is used to give desired qualities to foods through the influence on their viscosity, body and texture.

The biggest single use is in confectionery where, apart from giving body and texture to certain types of confection such as fruit gums or hard liquorice sweets of the Dutch variety (where it constitutes some 40 % of total ingredients and thus accounts for the majority of use in the confectionery field), it has two important functions; retarding the crystallisation of sugar and emulsifying the fatty flavour to keep it evenly spread throughout the sweet. In the former use, application is greatest in confections such as jujubes and pastilles where the sugar content is high and the moisture content low. In the making of caramels and toffees, gum arabic prevents the fat from oozing to the surface and forming a greasy layer. Gum arabic also finds use in lozenges where it acts as a binding agent for the paste base. In solution, it provides a very effective initial coating on the centres of sugar-coated tablets or balls prior to the final coating. Another more recent use is in the preparation of dietetic gum drops for low-sugar and salt-restricted diets: in this use, the bulk and texture of sugar can be substituted for very satisfactorily by gum arabic.

These latter uses can be interpreted as belonging to the pharmaceutical field, where gum arabic is used in products such as the above and also semi-confectionery goods such as cough pastilles. It is also used, however, in true medicinal preparations where it has two important and separate functions: it can be used as a binding agent or a coating for pills, usually of the ultimately sugar-coated variety, and as an agent for suspending or emulsifying drugs.

An increasingly important use of gum arabic is in the soft drinks industry, where it is used as an emulsifier in the preparation of many flavour emulsion concentrates, such as orange, lime or cola. The function of the gum arabic, besides giving body to the soft drink, is to keep the globules of flavour oil apart, thus preventing them from coming together to form an oily ring round the bottle. Gum arabic is very effective in this use, but the mechanism of emulsification is still not completely understood. According to Glicksman[1], it is believed that the gum arabic, as a film-forming agent, prevents coalescence of the oil globules and so permits a high degree of dispersion by diminution of the diameters of the globules.

In recent years, the use of powdered or dried flavours, both in the food and soft drinks industries, has grown rapidly and with this growth the popularity of encapsulated or locked-in flavours has increased tremendously, particularly in dry mix products such as desserts, cake mixes, soup mixes, beverage mixes and so on, where flavour stability over time is of major importance. Most of these types of flavours are prepared by a variation of the spray-drying process, in which a solution of gum in water, with the flavour suspended in this solution is forced through a fine nozzle at very high temperatures; the water evaporates and leaves the particles of flavour protected by a film of gum. This seals the flavour until it is released on re-immersion in water during the final preparation of the food product. The preparation of spray-dried flavours dates back to 1927 and since that time gum arabic has been the preferred gum for this purpose.

Gum arabic has a variety of other minor outlets in the food and drink industries. It is used in the baking industry, where its water-absorption property is an advantage. Because of its water-absorbing properties, gum arabic has often been used as a stabiliser in the preparation of frozen products, particularly ice cream where the gum produces a fine texture by retarding the formation of ice crystals. Unfortunately, when gum arabic is used for this purpose, the ice cream does not melt readily and so other gums have generally been preferred for this purpose.

Another significant use of gum arabic is in the brewing industry where gum arabic is used to stabilise the foam; indeed, it is largely responsible for the 'lace curtain' effect on the sides of the glass when the beer is consumed[1]. About 2.5 – 3 pounds of gum arabic is normally sufficient to stabilise 50 barrels of, beer.

Gum arabic has very many other applications in the food and beverage industries but they are quantitatively negligible and in most cases, gum arabic has been superseded by substitutes.

The non-food applications of gum arabic are equally varied, but the major technical outlet has traditionally been in the adhesives industry, where again it has two principal functions: it can be made into a mucilage, by solution in water, for general domestic and office use; it is also the base of a remoistenable adhesive for use on products such as stamps or envelopes. Where remoistenable adhesives of high quality are concerned, gum arabic has the advantages of tastelessness and 'non-blocking' (the property of not becoming sticky in humid weather).

The one other major technical use of gum arabic is in the lithographic printing industry where it has three functions. It is used as a base for light-sensitive chemicals employed to form images on the lithographic plates by photographic means. In the printing process itself, it forms part of the prepared solution used to make the surfaces of metal plates repellent to lithographic inks during the printing process, and lastly it is used to protect the surface of the plates in storage from oxidation and dust.

Gum arabic has traditionally been used as an emulsifying agent in the paint industry, but has been largely superseded and now finds limited use, principally in the preparation of poster paints and water colours. Its use in recently developed water-emulsion paints is limited due to its unfavourable effect on the water resistance of the final paint film, but it has found some outlet in the preparation of vinyl resin emulsions.

Similarly in the ink industry, the majority of record inks or fountain pen inks no longer include gum arabic, although many special purpose inks still make use of its excellent protective colloidal properties: it stops the ink from spreading on the surface to which it is applied and also controls the flow of the ink from the pen.

In textiles, gum arabic at one time had a large outlet. Gums are commonly used in the textile industry as sizing and finishing materials and in printing formulations for imparting patterns to the fabrics. Gum arabic still finds limited use in finishing silk and rayon materials: it gives 'body' to the fabric without reducing its transparency in any way.

Lastly, gum arabic has in the past had a variety of applications in the cosmetics field where a wide variety of gums and thickeners are extensively employed in cosmetic and toiletry formulations. (Indeed, gum arabic was known and used by apothecaries and pharmacists for many centuries BC). These materials are used in many products, a number of which are: foundation creams and lotions; hand creams; depilatories; antiperspirants and deodorants; and many male toiletries. Quantitatively, however, the use of gum arabic in this field is negligible.

Part VI

Substitutes

In theory, all water-soluble gums are mutually substitutable; preference in practice is given to a particular gum on the grounds of slight advantage in performance or price, or merely on grounds of tradition. Therefore, gum arabic faces competition from any water-soluble gum and so considerable attention must be given to this wide range of possible substitutes.

The total production of water-soluble gums is very great, the United States market alone accounting for some 1 800 000 tons annually. Out of this overall total for the US market, only some 135 000 tons find employment in the food industry where the bulk of gum arabic is used. Water-soluble gums comprise essentially three categories: natural gums, modified natural gums (modified in the sense that their chemical properties are changed), and synthetic gums. Although the latter two categories are growing at a rapid rate, natural gums still account for more than 95 % of the overall market for water-soluble gums.

To avoid confusion, it should be pointed out that gums which have been physically modified, essentially starches, are termed 'natural gums'; only gums which have been modified chemically are considered under the heading, 'modified gums'.

Natural Gums

The natural gums are many and varied and so only scant attention can be paid to any one of them. Emphasis will be given to those gums which are believed to provide the greatest competition to gum arabic, whether actual or potential.

Plant Exudates

There are many well-established plant exudates, but only four are referred to in this section, aside from gum arabic itself.

Gum tragacanth is probably as effective an emulsifying agent as gum arabic, although it performs this function in a different way. A synergistic effect occurs with gum arabic and gum tragacanth; i.e. a mixture of the two gums in certain proportions is a more effective emulsifier than either of the gums alone. But the use of this gum in the food industry is very much less than that of gum arabic, quantitatively around 8 % of the latter. The major reason for this is the price differential: the price of tragacanth varies, depending on type and quality, but even the cheapest grade is 3–4 times as expensive as gum arabic. [The cost given to gum arabic in this section on substitutes is that of a typical powdered food-grade gum arabic. Therefore, it is likely that in many instances the relative cost of gum arabic is less than that suggested, by around 20 % of the price of the powdered gum.]

Gum karaya is another emulsifying agent, which has at times been included with gum arabic and gum tragacanth to improve the synergistic effect. The use of gum karaya in the food field is around 4 % of that of gum arabic, and it sells for approximately twice the price of gum arabic.

Gum ghatti is also an alternative emulsifier, and sells for around the same price as gum arabic. However, its popularity is rather limited and quantitatively it is used to the extent of less than 2 % of gum arabic in the food industry.

Arabinogalactan is found principally in larch trees, where it accumulates in masses under the bark of the tree following injury. The best commercial source of the gum is the Western larch (*Larix occidentalis*), indigenous to the northwestern USA. It has been estimated that some 13 500 tons of this gum could be extracted from the wood residue available from present lumber activities.

Arabinogalactan threatens to provide strong competition to gum arabic in certain uses. It has the important properties, similar to those of gum arabic, of producing very low viscosities at low concentrations and of being extremely soluble, so that solutions of up to 60 % can be prepared. Commercial interest in this gum revealed itself only in the early 1960s when a new extraction process was developed and so it has found only limited commercial application as yet. Indeed, it was not cleared for food use in the USA until 1965. But it has found some use in the lithographic industry and also as an effective flavour fixative in specific applications. In soft drinks, it is claimed that arabinogalactan is a very efficient emulsifier and gives excellent 'body' to the drink. The exact price of this gum is not available but, although a by-product of the lumber industry, it is considerably more expensive than gum arabic. This price differential limits arabinogalactan's competitiveness.

Plant Extracts

Two gums which are derived from bean plants are guar gum and locust bean gum. Of the two, guar gum is more competitive with gum arabic in outlets such as textile printing or the stabilising of ice cream. Guar gum is used extensively in the cosmetic industry, where it serves to improve the flow characteristics of lotions and creams. In quantitative terms, guar gum consumption is fairly large but in the food industry its usage is only half that of gum arabic. Locust bean gum consumption is very much smaller, both overall and in the food industry. On price grounds, both these gums are competitive with gum arabic, normally selling at a slightly lower price.

Seaweed Extracts

There are a variety of seaweed extracts which find extensive and varied use in the food and other industries.

Agar-agar, which originates in Japan, is used mainly in the food industry, where its gelling properties at high temperatures make it particularly useful in baking. Quantitatively, the consumption of this gum is very small indeed, mainly because of its very high price: it sells for at least eight times the price of gum arabic.

Carrageenan is a seaweed extract produced mainly in Europe and North America. It is very much more important commercially than agar-agar; its price, although expensive, is perhaps 50 % that of agar-agar.

Furcellaran is a seaweed extract which achieved commercial significance during World War II as a substitute for agar. It has since maintained and increased its market, although it is still small relative to agar. Furcellaran sells for half the price of agar, or about the same as carrageenan.

Lastly, there is the most important seaweed extract, algin, the main source of which is the giant kelp, *Macrocystis pyrifera.* Alginate manufacturing plants exist in the USA, the UK, Norway, France and Japan. World production in 1964 was estimated to be around 14 000 tons. There are a variety of food grade alginate products, which sell within a range of approximately £1.54 – £1.65/kg, depending on the viscosity required. Alginates have not risen in price by nearly as much as gum arabic and food grades now compete almost directly with gum arabic on price terms. Alginates are used in the food industry for the stabilisation of ice cream and for suspending the fruity particles in soft drinks; in the brewing industry they improve the clarity of the beer and increase the foam stability.

Pectins

Pectins are prepared from the pectic substances which, in combination with cellulose and starches, are structural components of all green land plants, but are found mainly in fruit and vegetables. In the USA alone, about 2 250 tons of citrus pectin are produced annually as a by-product of the citrus fruit industy. The major outlet for pectin is in the production of jams and jellies. Pectin is considerably more expensive than gum arabic, selling for more than three times the price of the latter.

Gelatin

Gelatin is commercially manufactured from a variety of animal skins and bones. In the USA alone, as much as 30 000 tons are produced annually, and most of this production is used in the food industry, particularly in confections. A combination of gelatin and gum arabic has been used as a flavour fixative. The price of gelatin ranges from 50–150 % greater than that of gum arabic.

Starches

The largest group of natural gums, as here defined, is derived from 'starches'. In quantitative terms, starches and starch derivatives have as much or more than 85 % of the total market for water-soluble gums. The materials of particular relevance to this report are the 'modified starches'.

Raw starches are modified in order to obtain combinations of properties suitable for specific applications. These modifications can be carried out in various ways, but the method of primary relevance is that of conversion by hydrolysis. This process involves breaking the carbohydrate chains of the starch molecules followed by rearrangement and recombination to form low viscosity products. Depending on the type of starch and the conditions of hydrolysis, many variations in solubility, gel strength and viscosity can be incorporated into the final product. Raw starches such as corn starch cost about £70 per ton and prices then range up to £300 per ton for many modified starches. Dextrins, a form of starch, are now rarely used in the food industry because they are a relatively crude product compared with the more highly modified starches. They are however very cheap, about 10p/kg.

Modified natural gums

This sub-section concerns a relatively new but growing category of gums, the chemically modified natural gums. Almost all of these gums are based on two very cheap starting materials, starch and cellulose pulp. It is quite possible that, given sufficient time, these modified gums could be tailor-made to suit the requirements of any specific outlet. The problem is that the initial research and the subsequent processing costs might result in the price of the products being so high that they are not competitive with natural gums. An added expense is that any such new gum must undergo extensive testing before it is permitted in food products; as a result, the tendency is to look for technical applications for these gums. Countering these disadvantages, there are several definite advantages which these gums have over the natural gums: uniform properties; stable prices; and once available, they remain so in relatively unlimited quantities. The most commercially significant of these gums at the present time are as follows.

Sodium carboxymethylcellulose (CMC)

CMC, in quantitative terms, is by far the largest of this group of gums. Probably its largest use is as a soil-suspending agent in detergents, but it also finds significant application in the food industry, paper and textile sizing, paints, and pharmacy. Around 12 % of total production is used in the food industry, where its major outlet is in the stabilisation of ice cream. It is also used to control the crystallisation of sugar in confectionery work and to stabilise beer foam. CMC is an effective flavour emulsifier in soft drinks and could probably be used to encapsulate dry powdered flavours. Up until the unprecedented high prices being quoted for gum arabic in 1973, CMC was, generally speaking, the more expensive material. Prices of edible grades range from between £500 and £1 200 per ton. As far as is known there is no UK production as a large wood pulp industry is required to provide the basic raw material.

Methyl cellulose (MC)

MC is a strong emulsifying agent which finds extensive use in the following industries: cosmetics, paints, foods, paper and textiles. Although considerably smaller than CMC in quantititive terms, it has comparable significance in the food industry, where perhaps 33 % of its total production finds an outlet.

In the food industry, MC is incorporated into baked goods, dehydrated foods and dietetic foods. In soft drinks, it can provide the necessary body in sugarless drinks.

MC is more expensive than CMC, and perhaps twice as expensive as gum arabic.

Others

Two other relevant materials in this group are ethylmethylcellulose, known commercially as cellofas, and a microcrystalline cellulose known commercially as avicel. This latter material finds widespread application in pharmacy, where its binding capacity and absorptive power is used in pill-making, and in cosmetic work where it is used in the preparation of various creams and lotions. The former product, cellofas, finds some use in the lithographic printing industry. It is likely that both are more expensive than gum arabic.

Synthetic gums

These are a range of gums which are completely synthesised from chemical materials. Generally speaking, these have the same advantages over gum arabic as the modified natural gums and also the same disadvantages, particularly with respect to cost and difficulty of acceptance for food application.

Polyvinylpyrrolidone (PVP)

PVP is produced in large quantities but only a fraction of this production finds an outlet in the food field, presumably because of the difficulty of satisfying the food and drug regulations in some countries, particularly the USA. It is used in the beverage industry as a clarifying agent. However, it is likely that its excellent protective colloidal function will be exploited in the future, thus giving a large market in the food industry to PVP. At the present time, it has extensive application in cosmetics, particularly in hair sprays and similar products. PVP is rather expensive, selling within a range of some £1.53 – £2.50/kg, depending on delivery lots required. This is several times higher than gum arabic despite the latter's inflated price in 1973.

Polyvinyl alcohol (PVA)

The production of PVA is in fact considerably larger than that of PVP but it finds little application in the food industry. Its major uses are in the adhesives industry and as a sizing material for textiles and paper. It has been used as a thickener in chewing gum. PVA normally sells at around £300 per ton, but the situation concerning supplies of material is likely to deteriorate with an overall shortage of synthetic resins because of supply problems in the petro-chemical industry and the price is expected to rise to £450 per ton. However, even at this level PVA is still competitive with gum arabic.

Carbopol

An interesting range of synthetic gums is the carboxyvinyl polymers, known commercially as carbopol. These materials have not yet been passed for use in the food and beverage industries, at least in the USA, and so are limited to technical outlets. Carbopol is relatively expensive, selling for between £3.04 – £3.66/kg in 22 kg lots.

General

The foregoing summary gives an idea of the number and variety of substitutes for gum arabic. Some comment on the nature of the competition is necessary.

On grounds of tradition, gum arabic has a tremendous advantage: it has been used in a wide variety of applications for many years, and those firms or industries which use it are naturally reluctant to change an accepted formula unless it is obviously far more costly or far less efficient than the available alternatives. It is often the case that, within a certain area of use, gum arabic is still employed in a few specific product formulae, while the firm or industry concerned has generally dispensed with its services: when these formulae become obsolescent or are reformulated, gum arabic will be excluded.

On grounds of quality, gum arabic has one basic disadvantage: the composition of every batch of gum arabic varies, no matter how slightly. This is a major drawback in the more sophisticated uses, particularly in pharmacy but also in confectionery and other outlets. Non-natural gums do not have this problem. In terms of continuous availability, gum arabic is again at risk, since a poor crop can result in large shortages, as is happening at the present time.

On price grounds, gum arabic suffers a minor disadvantage in that its price is variable, depending on the supply and demand conditions at any time. It is likely that the price of any modified or synthetic gums, which are almost always produced by the chemical industries of the developed countries, will remain stable. But, in terms of relative prices, gum arabic is generally considerably cheaper than most alternatives, with the exception of dextrins, and so is preferred on price grounds. However, the price per unit quantity of the various alternatives is not necessarily an accurate measure of relative costs. Different quantities of different materials perform the same function and it is generally true to say that lesser quantities of the modified and synthetic gums produce the same results as, say, gum arabic. Therefore, no conclusions on relative cost must be assumed from unit price differences alone.

The fact remains, however, that gum arabic in many of its outlets has a definite superiority in performance over even the most effective substitute. This superiority must be more than compensated for before gum arabic is actually replaced in any use.

Substitution by area of use

In this sub-section the various substitutes are considered as they affect gum arabic in each of its major uses. A more precise quantitative estimate of their effect is attempted later in the report.

Confectionery

There is only one important type of substitute for gum arabic in this field: dextrins or modified starches. Pectin might be considered a substitute, but only an indirect one in the sense that softer gums made from pectin compete with harder gums made with gum arabic. Pectin cannot be used as a base for a hard gum. Dextrins have already made a large impact on the demand for gum arabic in confections: the bulk of the confections known as gum drops, which were at one time prepared exclusively with gum arabic, is now based almost exclusively on dextrins. Substitution is almost complete in the manufacture of liquorice gums also. Dextrins have a very great price advantage over gum arabic and are supplied in a form which can be incorporated directly and easily into the formula, whereas gum arabic, depending on the form in which it is purchased, can necessitate prolonged preparation before use. The great disadvantage of dextrins is that they cannot produce as hard a product, or a product which takes as long to dissolve. However, improvements in dextrins are continuously being made and it is likely that in the near future they will provide a very competent substitute, the relative price differential overcoming any slight qualms concerning inferior performance.

CMC is a possible substitute for gum arabic in its function of retarding sugar crystallisation, but at the present time its impact appears to be negligible.

Flavours

(a) *Soft drinks*

In the soft drinks industry there are a variety of possible substitutes for gum arabic: these vary from fellow plant exudates, such as gum tragacanth, gum karaya and the recently developed arabinogalactan or larch gum, to the synthetic gums, CMC and MC. Sodium alginate is also a possible substitute in certain fruit drinks. In 1971 the development of a starch for emulsifying soft-drink beverage flavours based on a waxy starch extracted from hybrid corn posed yet another threat to gum arabic and its position in the soft drinks industry is slowly being eroded.

(b) *Spray-dried flavours*

At the present time the use of gum arabic as a protective coating for spray-dried flavours is well established and there seems no likelihood of substitution in the near future. Other materials, such as modified starches, gum tragacanth or CMC have been tried but have been found to be relatively unsuccessful. Larch gum has been reported to be as effective as gum arabic for certain types of flavours and may therefore present a danger in the future. Apart from direct substitutes, new flavour fixation techniques such as microencapsulation (which would probably involve gum arabic in combination with gelatin) and alginate film encapsulation are being investigated. But, for the time being, gum arabic maintains its supremacy, although current high prices mean that companies are increasing their research into substitutes.

Other food outlets

In the smaller outlets for gum arabic in the food and drink industries, gum arabic either never was an important ingredient, or it has been ousted from its position of superiority. In the making of ice-cream, more efficient and more desirable stabilisers such as carrageenan, locust bean gum, gelatin, CMC and sodium alginate, or combinations of these have been found and gum arabic has already been effectively replaced.

In the brewing industry, gum arabic is still used in significant quantities, mainly in the USA, but it has been largely superseded by more effective materials, particularly sodium alginate but also CMC and PVP.

Pharmacy

In pharmacy, gum arabic has a variety of applications. Relating to its use in lozenges and cough sweets, etc, what has been said concerning the possibilities of substitution in confectionery essentially applies to this application. However, since the demand for cough sweet products is likely to be more price-inelastic than the demand for ordinary confections, the producers are perhaps less cost-conscious and therefore less likely to substitute a dextrin which is inferior in performance to gum arabic.

In the more strictly pharmaceutical applications of gum arabic, as an emulsifying and a binding agent, it is threatened severely. The disadvantages of gum arabic are that its properties vary from batch to batch, and that it carries a certain bacterial load which is frequently too high for the very strict regulations of some of the Continental countries. In its emulsifying work, gum arabic has largely been replaced by a variety of synthetic emulsions, particularly with methyl cellulose preparations. These are not much more expensive since less quantity is necessary to perform the same function. Gum arabic still has significant use in this field which will probably continue for many years. But it is very unlikely that it will be included in any new formulations.

In its use as a binder in tablet-making gum arabic has a safer market, but it is still threatened by other materials which can perform the job equally well. The most effective competitors in this field are 'avicel', which has a strong binding capacity and considerable absorptive power; PVP, and the carboxvinyl polymers ('carbopol'). Again, it can be said, although with less certainty, that new formulations are unlikely to include gum arabic as a binding agent. However the traditional nature of many of the formulations in pharmacy still safeguards to some extent the use of ingredients such as gum arabic.

One of the major applications of gum arabic is in the making of a sub-coating syrup for the sugar-coating of tablets, where presumably both its binding and emulsifying properties are valued. Unfortunately, sugar-coated tablets are being gradually replaced by alternatives, usually film-coated tablets or capsules. This trend has not progressed far in the UK as yet, but in the USA it is probably true to say that almost no new products are marketed with a sugar-coating. This trend will obviously reduce the demand for gum arabic.

It is perhaps well to emphasise that in pharmacy change only takes place when a potential substitute has given liberal proof of its superiority and that although there may be superior substitutes for gum arabic on grounds of performance and even price, the demand for gum arabic in this field will fall only gradually.

Adhesives

In the adhesives industry gum arabic has lost a great deal of its market to dextrins, particularly in the field of general mucilages. The sole advantage of these modified starches is their cheapness, a factor which more than compensates for the rather unpleasant taste they produce in adhesives. The use of gum arabic in general mucilages is almost negligible at the present time, except for its use in some traditional formulae which have not yet become obsolete.

Its use in remoistenable adhesives of superior quality is still considerable but here again substitutes are beginning to make inroads. It has been reported that improvements in dextrins have resulted in a dextrin which does not have a bad taste, and so such 'sophisticated' dextrins are a potential competitor. But the major threat in this use comes from polyvinyl alcohol-based adhesives, which are becoming more popular. These adhesives give a very high performance and apparently have the advantage, besides being far easier to incorporate in a formula, of producing variable viscosities. The key advantages of such adhesives are their controlled quality and stable price. Neither do they suffer from the traditional problems associated with gum arabic such as tendency to foam and the necessity for filtering to ensure cleanliness. Although PVA is considerably more expensive than gum arabic per unit weight, less is needed and so the relative costs of the two materials are about the same.

Lithography

There are several substitutes for gum arabic in the field of lithography, but opinion differs as to their effectiveness. Some state that no substitute can provide as good a performance as gum arabic, while others are equally adamant that the market is being threatened severely by substitutes. The truth of the matter is probably that the substitutes have not had much effect so far, but that they do pose a dangerous threat for the future.

In the field of water-soluble light-sensitive coatings, the most probable substitute is polyvinyl alcohol (PVA), although arabinogalactan has also performed very well in this use. PVA has the already-mentioned advantages of having less variation from batch to batch and also, being a synthetic, its properties are subject to greater control. For the purpose of desensitising etches, CMC is the one important substitute which is already making some impact; PVA, which is a poor desensitiser, is not a competitor. Ethylmethylcellulose (trade name, Cellofas) is also a possible substitute for this purpose but, although a little cheaper, it tends to produce a thinner solution than is desired.

But perhaps the major threat to gum arabic in the lithographic printing field comes from the existence of presensitised plates which do away with the need for gum arabic as a desensitiser. These are currently available and have made severe inroads into the use of gum arabic in this sector. This new process is more expensive than the traditional one but it has the important advantage of being very much quicker.

Paints

In the paint industry, the market for gum arabic is declining. It is still used in the preparation of certain paint emulsions, but these compete with a great many other types of emulsion. The stated disadvantages of gum arabic are again that it is variable in quality and also that it tends to impart a brown colour to the emulsion (this may be due to the use of an inferior type of gum arabic). Also, the inclusion of gum arabic in a water-emulsion paint has an unfavourable effect on the water resistance of the final paint film. The major substitutes for gum arabic in this field are PVA and the cellulose ethers, particularly methyl cellulose. These products are more efficient and, although it is unlikely that direct replacement will occur, the present trend will continue with the popularity of the emulsions containing gum arabic decreasing and no new emulsions incorporating it being formulated.

In the preparation of water-colour paints, gum arabic faces a declining market, at least in the production of cheaper paints, where dextrins have been substituted because of their price advantage. Where high quality paints are desired however, gum arabic still maintains its position and manufacturers, despite the material's rising price, continue to use it.

Inks

There is great diversity of opinion concerning the position of gum arabic in the preparation of inks. One large UK company stated that they no longer used it in the preparation of fountain pen inks and that it was unlikely that any firm still used it; another large firm stated that they still used gum arabic and that there was no reliable substitute. The overall position seems to be that gum arabic is being used to a lesser extent in the preparation of fountain pen inks, having been replaced by synthetic substitutes which, if not less expensive, are certainly as efficient and are more readily available. However, for many special purpose inks, gum arabic is still much desired for its excellent protective colloid action.

Apart from the direct effect of substitutes, the demand for gum arabic in the preparation of inks has suffered greatly from the reduced popularity of fountain pens relative to ballpoint pens. The production of fountain pen ink in any unit period is at present several times less than it was say, 5–10 years ago.

Textiles

The use of gum arabic in the textile industry today is very much less than it was previously. Its high cost prevents it from being used in the finishing of any cotton material. In the sizing of textiles, gum arabic at one time found significant employment, but always as only one component of a sizing material. This use has now been superseded almost completely by various compound sizes which usually consist of a starch base, together with a lubricant, and a polymer such as PVA or CMC.

Cosmetics

In the large and continually growing business of cosmetics, gum arabic has traditionally played a small role, one which has become negligible at the present time. Like the other vegetable gums, gum arabic has been replaced by a variety of synthetic and semi-synthetic materials which perform its function more effectively and do not suffer from the already-emphasised disadvantages of a natural plant material. Among the more popular of these materials in the cosmetics industry are CMC, MC, PVA, PVP and the carbopols.

Part VII

Trade Structure

General

The structure of the trade in gum arabic has already been discussed up to the point of export. This section of the report deals mainly with the trade structures in the importing countries and the demands of different users for different qualities and forms of gum arabic. The available information on the United Kingdom trade structure is the most comprehensive and so the main emphasis of this section will be on the UK; much of what is said concerning the UK also relates to other markets, but where special factors are of importance to individual trade structures, these will be discussed.

Generally, the trade structure in the major markets is for a merchant to buy the supplies of gum arabic, and either resell them in the same form or process them before resale to the ultimate users. Since the nationalisation of the Sudanese industry in October 1969 the position has changed somewhat and it is possible that there may be important consequences. Before then, at least in the UK and probably in the other large importing countries, a broker played a fairly large part in the trade, performing essentially two functions: 1. acting as a middleman between buyer and seller and thus keeping the identity of the buyer secret; 2. selling on a consignment basis. With the nationalisation move and the consequent existence of a monopoly supplier of Sudanese gum arabic at constant prices which was prepared to sell to anyone provided the order was not less than 10 tons, the broker became redundant and has virtually disappeared from the trade.

Theoretically, the gum arabic merchant in the importing countries was in danger of eclipse also, but he has retained his position because he acts not merely as a middleman but provides the valuable service of processing the gum to the differing requirements of a variety of users. Also, there are still very many users of gum arabic whose individual requirements do not amount to anything like 10 tons in a year or so, and the merchant still provides such customers with a valuable intermediary service. Furthermore, many users who buy gum arabic in quantities very much larger than 10 tons and who purchase the gum in the form in which it is imported, continue to buy their supplies through a merchant. The reason for this is a combination of two factors: one is that the merchant provides the service of supplying their requirements at a small cost: the other, partly connected with the first, is that as existing trading arrangements are satisfactory there is no positive incentive to change them.

Nevertheless, the nationalisation of the Sudanese marketing system encourages the large users of gum arabic to buy direct from the Sudan and thus do away with the merchant's services. There is not a great deal of evidence to suggest that this change has actually occurred, but a few of the larger user firms certainly have considered this possibility and may have put it into effect. It is likely that many of these larger firms who buy gum arabic in the form in which it is imported and do not therefore require the processing services of the merchant will eventually buy direct from the Sudan. This likelihood perhaps partly explains an increased emphasis on promoting alternative sources of supply where the merchants' processing services will still be required.

United Kingdom

With the eclipse of the brokers, the UK trade in gum arabic is at present dominated by five or six merchant houses located in London, plus one or two situated in Manchester to deal with the gum imported through Liverpool. These buy direct from the Sudan or, in the case of Nigerian gum and gum from the ex-French territories, from British shippers and French merchants respectively. The shipping merchants who supply Nigerian gum arabic do not process the gum. UK imports from the ex-French territories are still relatively small but there is probably an increasing tendency to buy direct from this region rather than through French merchants in Bordeaux, although the latter may still arrange the purchase.

These few importing merchants are the crux of the trade structure: they either resell the gum to the ultimate users, or possibly to a smaller merchant (but this is rare) or process it and then sell to the user. The proportion of the gum processed before being supplied to the ultimate consumer is difficult to estimate precisely. Each of the processors has his own idea of what the proportion is and estimates vary from 5 % of imports to 25 %. The statistical mode is 10 % while the mean average is 13 %. The true percentage processed probably lies within these two figures. Most of the mercahnts have their own processing plant, but one or two contract a fellow merchant to grind their gum.

The processing of gum arabic essentially involves two functions: cleaning and grinding. Cleaning consists of ridding the gum of foreign agents such as fibre and bark, a function which is being increasingly performed in the country of origin, and grinding consists of breaking up the gum into particles of smaller size, usually kibbled or powdered. Even within the powdered class, there are several degrees of fineness of powder which are prepared according to different specifications. In particular, the processing merchants prepare powdered gum arabic (or Acacia as it is known in pharmacy) according to the *British Pharmacopoeia*[2] specifications. Almost all of the gum arabic used in pharmacy, and certainly all of the gum arabic used in dry powder form in pharmacy, is prepared by these specialist processors. Gum for use in pharmacy must conform to strict specifications and so only the hand-picked selected grade of Kordofan gum is used for its preparation.

Pharmacy is the only use where it is so simple to state the type, quality and form demanded. Powdered gum arabic is also purchased by certain confectionery firms, who value its high quality and its ability to dissolve almost immediately. (Whole lumps of gum arabic can take 48 hours to dissolve properly.)

Similarly, the kibbled grade of gum arabic (i.e. small particles but not as small as the powdered particles) is desired by many individual users in different industries. The essential advantage of this form is that the gum dissolves more quickly than in lump form. In the preparation of kibbled gum, it may be that more than one grade of Kordofan is used in its preparation, but generally it will be kibbled from the cleaned Kordofan grade. It is never the case that gums from different sources are ground together in any preparation, according to the processors.

Thus, where ground gums are necessary or preferable, the merchant-processors provide a very valuable service to their customers. According to one merchant, a single pulverising mill costs £3 000, a rather large investment for any firm which uses only a few tons of gum arabic in a year, as is the case with most pharmaceutical firms. The customers are quite willing to pay a premium for this service.

Yet probably no more than 13 % of total UK imports are processed before reaching the ultimate consumer. This is because the desire for a processed gum arabic depends very much on the use to which it is ultimately put: if a user is eventually going to put the gum arabic in solution, as is normally the case, then it is rational to buy it in lump form. When the gum dissolves, the dirt and impurities will either float to the top or sink to the bottom; either way they can easily be removed. Of course, as has already been mentioned, lumps of gum arabic take a long time to dissolve properly in cold water and many customers, particularly the smaller ones, may prefer to pay a premium for the convenience of buying the gum in a form which will dissolve more easily and more quickly. But the large users of gum arabic, who have the necessary facilities either for breaking down the gum or for increasing the rate of dissolution, or who can allow the gum time to dissolve, buy their supplies in the natural grade since they have the necessary equipment to clean and process the gum to their own requirements.

It is therefore impossible to forecast a trend in the proportions of gum arabic processed before reaching the ultimate user: large users generally buy unprocessed gum; small users tend to prefer the convenience of processed gum, although some buy the lump gum and allow it to dissolve in its own time.

Concerning the demand for the different grades of gum, the pharmaceutical demand is for the highest quality of gum, the hand-picked selected grade. It is difficult to generalise on demand in the food and drink industries: some discriminating customers prefer hand-picked selected while the majority use the Kordofan cleaned (this, of course, does not mean that they are in any sense using an inferior grade of gum; they possibly have the facilities necessary to clean the gum which the purchasers of the more expensive grade lack). It can be said that technical users purchase the inferior grades of gum arabic, in the sense that a No.2 quality Nigerian gum arabic, or Kordofan dust, or Sudanese tahl gum, will find exclusive use in non-food applications. But most technical users of gum arabic probably use the cleaned Kordofan grade and for particular applications such as in lithography, it has been reported that only gum of the very highest standard is adequate.

Gum from sources other than the Sudan has traditionally not found a wide market, particularly in food or drink applications. This discrimination has lessened in recent years and is certainly partly based on traditional prejudice, although it would appear that Nigerian gum is now being used successfully by at least one member of the confectionery trade.

United States of America

The American trade structure is very similar to the British, with a group of merchants importing supplies from the Sudan (before nationalisation, this was done through agents of the exporters in many instances) and either processing the gum before selling it to the final consumer or reselling it as such. These merchants are almost all based in New York City.

However, there is one very important difference, if only of degree: a much larger percentage of supplies of gum arabic to the USA are processed before reaching the ultimate consumer. Various estimates of this percentage have been made and it is likely that the proportion thus processed by the specialist dealers could be as high as over 90 % and probably not less than 75 %.

A major factor in determining this very high proportion is the strictness of the regulations concerning the use of natural materials in any product which is to be consumed orally. Whereas such regulations apply only to the use of gum arabic in pharmacy in the UK, the US Food and Chemicals Codex Specification, lists stringent regulations for the use of gum arabic in the entire food and beverage field. These regulations involve more highly skilled processing and so most users pay a premium for the convenience of being supplied with the finished article. Most of the demand from the food and drink industries is for a powdered gum arabic and although quantitative figures are not available, correspondence with US gum merchants and processors indicated a significant and increasing demand for spray-dried gum arabic, a particular form of powdered gum which is discussed later in greater detail.

Even the technical users of gum arabic frequently demand a processed product: the lithographic industry prefers a coarse granulated gum, while other technical users provide a demand for the inferior gum which is a by-product of the milling operations of the merchant-dealers.

France

Little information on the French trade structure for gum arabic is available. As has already been stated, much of the basic grading of the gum is still performed in Bordeaux by the associates of the exporting interests in the ex-French territories. No estimates are available on the proportions processed by these merchants prior to supplying the ultimate users, but it is likely that the proportion is no higher than that processed in the United Kingdom. Much of the gum arabic for use in pharmacy is processed and the preferences of different industries for different qualities are probably much the same as in the UK, except that the bulk of the demand is for gum originating in the ex-French territories.

Others

The trade structure in all other major markets is essentially similar to the UK prototype, as far as is known. One or two merchants dominate the trade, supplying most of the varied users. Generally speaking, a smaller percentage of the supply is processed and perhaps none at all in some of the smaller markets. This is partly because, in the traditional uses to which gum arabic is put in many countries, the user firms have acquired the necessary equipment and skills to prepare the gum arabic according to their own specifications. A probable exception is Japan, where it is very likely that a large proportion of the gum arabic is processed before being supplied to the users. The pharmaceutical industries in all these markets still require the bulk of their supplies in powdered form and this probably accounts for most of the processing performed in the countries.

In some of the smaller markets, however, gum is imported in powdered form from large merchants in the UK, France and the USA.

Spray-dried gum arabic

The introduction of spray-dried gum arabic in recent years has led to it supplying an increasing proportion of the overall demand for gum arabic in various fields. This spray-dried product is prepared by the same method as was described under the section relating to the use of gum arabic in the flavour industry, except that no flavour is present: the gum is prepared in a water solution and is shot through a nozzle while being subjected to high temperatures. The water evaporates and the gum arabic is left as fine particles of clear gum. Gum prepared by this method has three advantages: it is absolutely clean; it has a lower moisture content; and it is more readily soluble. Thus, it is far simpler to use than almost any other form of gum arabic.

The reason for the sharply increased popularity of this form of gum in the preparation of soft drinks is that the spray-drying process reduces the enzyme activity of the gum. Gum arabic normally contains certain enzymes which, in the preparation of soft drink concentrates, act on the gum itself (and perhaps other ingredients of the concentrate) with the result that the 'body' of the soft drink is ultimately decreased. This 'thinner' soft drink is not desirable. Under the conditions of the spray-drying process, the high temperatures deactivate the enzymes and so these undesirable side-effects do not occur.

The demand for spray-dried gum arabic in the USA is now reported to be very large although the exact quantities used are not known. This form of gum is prepared by three or four of the specialist processors already mentioned and it is becoming increasingly popular. According to US trade sources contacted, the US soft drinks industry where spray-dried gum was first introduced has now largely gone over to the use of the spray-dried variety, and inroads are beginning to be made among users in both the food and the pharmaceutical industries. It has been reported that a firm which uses gum arabic for some technical purpose has shown interest in the spray-dried form.

Outside the American market there appears to be no interest in spray-dried gum arabic. One of the large UK merchant-processing firms has prepared a spray-dried gum arabic but their market penetration remains minimal. The one great disadvantage of the spray-dried gum is its price: it costs approximately 50 % more than crude Kordofan, although only around 25 % more than the powdered gum. This differential appears to underlie the lack of interest in the UK. It has been suggested that the spray-dried form is only necessary if the firm concerned has neither the facilities nor the technical knowledge available to prepare gum arabic according to its own specifications. This may be largely true but the convenient form of spray-dried gum arabic is a great asset to many users.

This apparent lack of interest revealed itself in all the other major markets, where again the primary drawback was the high price. In some markets, members of the trade did not know of the existence of spray-dried gum arabic. However, it is possible that, with the trend towards increasingly strict regulations on the use of any material in the food, drink and pharmaceutical industries in many of the major markets, a demand for a purer form of gum arabic, such as the spray-dried variety, will eventually arise.

Part VIII

Import duty

The imports of gum arabic are free of duty in all countries except India, where there is an import duty of 60 % *ad valorem* (50 % if from a British colony, and free if from the United Kingdom or Burma).

Part IX

Markets

General

This section concerns the markets for gum arabic in the major importing countries. In recent years, the three largest importers have consistently been the USA, the UK and France, with Italy, the Netherlands and the Federal Republic of Germany following closely behind. Apart from India, which is a special case, there are another seven countries which regularly import over 1 000 tons of gum arabic per annum. Many of these latter countries, together with other smaller markets, import some of their supplies from the larger importers of gum arabic: this re-export trade is considerable and has remained fairly stable at around 11 % of total initial imports in the 12-year period up to 1971, the latest year for which official trade statistics are available.

Again, this section is dominated by comment on the United Kingdom market, on which more information is available. Information on the American market is also fairly extensive, while some informed comment can be made on the other large markets. Where it is considered both valid and useful, knowledge on the UK market is extrapolated to form the basis of tentative conclusions on some of the smaller markets. All quantitative estimates made in this section should be accepted only as crude indicators of the direction and magnitude of the various market trends.

United Kingdom

Imports and re-exports are listed in Tables 4 and 5 of the Appendix

Until 1962 the United Kingdom was the world's largest importer of gum arabic: gross British imports averaged some 11 500 tons from the mid-1950's, but in 1962 gross imports fell sharply to only 8 226 tons. This slump continued into 1963, but in 1964 and 1965 imports recovered, reaching 11 400 tons in 1965. However, since 1965, imports have again fallen off and, despite a partial recovery in 1967, reached a low of 6 741 tons in 1971. These figures suggest a definite decline in the UK demand for gum arabic.

The re-export trade in gum arabic from the United Kingdom has always been significant, re-exports averaging 9.0 % and 10.7 % of total imports in the years 1957–59 and 1960–62 respectively. The re-export trade then suffered a slump, reaching a low of 5.1 % in 1966. Since then, however, re-exports have recovered considerably, being 15 % of imports in 1970 and 33 % of imports in 1971. Thus, the net UK market for gum arabic is considerably less than the gross market, the adjusted figures being as follows:-

Net UK imports of gum arabic (tons)

1964	1965	1966	1967	1968	1969	1970	1971
8 904	10 565	9 263	9 991	7 890	6 951	7 694	4 488

The UK has always imported the bulk of her supplies from the Sudan, but the latter's relative importance as a supplier to the British market has declined over the years, taking the full brunt of the overall decline in the market. Imports from Nigeria remained remarkably consistent from 1962 until 1968, at levels of between 2 000 and 2 500 tons per annum. Then in 1969 imports fell to 1 700 tons although 1970 saw a recovery to more normal levels, only to be followed once again by a downturn in 1971. The instability of Nigerian exports occurring after 1968 is thought to have been due to the disruption caused by the Biafran conflict, which affected the major provinces producing gum arabic in Nigeria.

Imports from other countries have been relatively small, but it is significant that imports from ex-Frence West Africa have risen sharply since 1967 from an average of less than 50 tons before 1967 to 1 331 tons and 1 816 tons in 1970 and 1971 respectively. This reflects the UK's increased interest in this gum. In 1963 and 1964, the UK imported 147 and 142 tons respectively from Tanzania, presumably for some technical use, possibly textiles, but this demand dwindled to negligible quantities in more recent years, although 81 tons were imported in 1971.

Breakdown by area of use

In interpreting the aggregate demand behaviour for gum arabic, reference has been made to the individual user industries. The major firms in each industry using gum arabic were contacted in an attempt to estimate the present breakdown of demand by end-use and the expected consumption patterns in the future. From the information which has been gathered,. certain tentative estimates and conclusions have been derived but, due to the incompleteness of the information, no accurate breakdown has been possible.

However, such quantitative information as was available has been used to produce the following estimated breakdown by area of use. The percentages are based on net UK imports.

About 90 % of the net imports of gum arabic are used in edible products, of which about 77 % is used in confectionery products 8 % in flavours and soft drinks, and some 5 % in various pharmaceutical preparations. The remaining 10 % is used for various technical purposes: of this 10 %, about 5 % is used in adhesives, 3 % in the lithographic industry, perhaps 1 % in the paints industry, and the remainder in other small uses.

This breakdown contrasts with earlier estimates made by the Tropical Products Institute in 1965 in that the relative importance of gum arabic in flavours and soft drinks has risen from some 6 % to 8 %, the proportion used in adhesives has fallen from 11 % to 5 % (thus continuing a fall from 15–20 % in 1960), although use in lithography has remained fairly constant at around 3 %.

Confectionery

Gum arabic usage is decreasing in the UK confectionery industry, for two reasons: the declining popularity of those confections which contain gum arabic and substitution by modified starches.

Up to the present time, most of the decline in the use of gum arabic can be attributed to the decline in popularity of gums and pastilles, which dominate the demand for gum arabic. The overall British confectionery production has stagnated over the last decade and the trade forecasts are that a fairly static market will continue in the foreseeable future. (British per capita consumption, averaging 11.2 kg per annum, remains the highest in the world.) But, within this static total, there has been a definite swing in consumer preference towards the more expensive chocolate confectionery. It also seems to be the case that there has been a slight shift in preference from the harder to the softer gums. The latter are based on pectin or dextrins.

Thus, despite widespread advertising of fruit gums, their production has been on a declining trend over the last 15 years or so. Indeed, 15 years ago, the major fruit gum producing company in the country purchased twice as much gum arabic per unit period as at the present time. About 10 % of this reduction in purchases was due to increased efficiency and 90 % to a reduction in sales of the end product.

The use of gum arabic in confections may have now dropped to as low as 5 000–5 500 tons per annum. Although there is no reason to assume that this downward trend in domestic consumption will cease, the relevant confectionery export trends may alleviate the situation.

A much greater threat arises from the possibilities of substitution by some kind of modified starch or dextrin. Gum arabic, on grounds of performance, is still very much preferred in fruit gums and pastilles, particularly in those fruit gums and the many semi-medicinal gums where the consumer expects the sweet to have a long 'sucking' life. Gum arabic, with its slow powers of dissolution, performs this function admirably. But gum arabic suffers two disadvantages in comparison with dextrins: the major one is that gum arabic is considerably more expensive and also its price has been continually rising in recent years; the other disadvantage is that gum arabic is a problem material because it needs much preparation before it is included in a confection 'mix'. Fortunately for the gum arabic market, confections as a group are rather price-inelastic and so a rise in cost can normally be passed on with little effect on demand. Nevertheless, continued price increases in a raw material do cause serious concern in the confectionery trade.

Until recently the possibility of substituting a dextrin for gum arabic would not have been considered, but improvements in the modification of starches are continually being made. The general consensus of opinion in the trade is that, although a substitution could not be made at the present time without reducing the desired qualities of the gum or pastille concerned, in two or three years it is quite likely that a satisfactory starch product will have been prepared. It is therefore likely that substitution will take place in these major lines, although probably only gradually over the next few years; but it seems reasonable to assume that, given time, the substitution could be total. It is impossible to estimate the rate of substitution at all accurately but, taking into account also the decline in popularity of fruit gums and pastilles, it does not seem over-pessimistic to suggest that the demand for gum arabic in the confectionery industry will fall at a rate of 5–10 % per annum in the next few years.

Pharmacy

It is estimated that up to 5 % of net UK imports of gum arabic is used in the field of pharmacy. Because of the very many small users in this industry, the estimate is based on the consensus of opinion among the processors of the gum. This percentage is intended to apply only to the quantities of gum used in 'true' pharmaceutical products and not that used in the manufacture of cough sweets and other such products.

The demand for gum arabic in pharmacy continues to decline as synthetic emulsions and tablet-binders take over. The likely trend away from sugar-coated tablets to film-coated tablets and capsules will serve to exacerbate the situation. Gum arabic suffers from the inherent variability of a natural material and even the preference for natural over synthetic materials in the preparation of any product which is to be orally consumed will not prevent its eventual demise.

However, gum arabic is at present incorporated in many formulations and it is highly unlikely that these will be altered. Conversely, it is unlikely that many new formulations will incorporate gum arabic as an ingredient. It is therefore probable that on balance there will be a gradual decline in the demand for gum arabic in pharmacy: a very crude quantitative estimate might be as large as 5 % per annum.

Flavours

The estimate that some 8 % of net UK imports of gum arabic is used in the flavour industry, errs, if anything, on the high side. Within this industry there are two distinct areas of use: as a protective colloid in the preparation of spray-dried flavours, most of which are subsequently used in the production of various convenience foods (only a small proportion is used in the soft drinks industry, since powder-based drinks are not popular in the UK); and as an emulsifier in the preparation of soft drinks.

Perhaps 60 % of the gum is used in the preparation of spray-dried flavours. It is believed that modified starches are used to provide the protective coating in the spray-dried process in Japan. Despite the continued expansion of the UK flavour industry, gum arabic is unlikely to be able to improve its position for three main reasons. These are the advance in spray-drying technology within the industry which has led to the use of substitute materials; gum arabic's disadvantage from a bacterial point of view and the recent shortages of supply and high prices of the gum which have further eroded its competitiveness.

The soft drinks industry has also expanded during the period 1961 to 1972 and production in 1972 was 32 % higher than in 1961. After 1966 production increased by an average 4 % per annum and this rate is expected to continue for some years to come. Until recently gum arabic had found increasing employment in the preparation of soft drink concentrates, amounting to some 40 % of its total use in the flavour industry. Substitutes are available but no completely satisfactory one has yet been discovered: some are less efficient, while others are synthetics which face rather stringent regulations on their use in any food or drink. However, increases in the price of gum arabic have meant that substitutes threaten to take over a considerable part of its use as an emulsifier in the preparation of soft drink concentrates.

Adhesives

The use of gum arabic in the adhesives industry continues to decline, to a present estimate of around 5 % of net UK imports. In the field of remoistenable adhesives, dextrins have taken over from gum arabic in lower-quality work and the traditional high-quality outlets such as the backing of postage and other types of stamps are also affected. Tradition and a certain lack of cost-consciousness had maintained this market intact for several years, but the improved performance of PVA-based adhesives and the continued increases in the price of gum arabic have resulted in the reduction of this market also. Gum arabic is no longer used as a backing for UK postage stamps, but the bulk of the demand for it still arises from its use as a remoistenable backing for various types of stamps for overseas countries. The UK still has a thriving export business in stamps, supplying over 100 foreign countries, many of whom still prefer a natural material such as gum arabic as a backing for their stamps. Some producers of remoistenable adhesives have indicated a desire to switch to substitutes but customers' requirements have prevented this to a large degree.

Extrapolating from the declining trends in demand over the past 10 years (demand fell by around 10 % per annum during 1960–65, and around 8.5 % per annum from 1965–70) demand will certainly continue to fall, but probably at a slower annual rate because of preferences in certain markets (postage stamps for overseas countries). It is estimated that the rate of decline of demand for gum arabic in the adhesives industry will approximate 5 % per annum in the next few years.

Lithography

The demand for gum arabic in the lithographic printing industry accounts for an estimated 3 % of net UK imports. The lithographic printing industry itself continues to expand at a fairly rapid rate: a rough guide is that; if the overall printing industry expands at x % per annum, the lithographic side expands at a rate of 2x % per annum. A crude estimate of the present rate of expansion of lithographic printing capacity is 10 % per annum. Assuming this rate of expansion to continue then the demand for gum arabic, other things being equal, will rise accordingly. However, it is almost certain that the demand for gum arabic has been affected to some extent by substitutes and the increasing acceptance of pre-sensitised plates, with the result that the demand may rise by only a maximum of some 5 % per annum in the next few years, after which time it may level off before ultimately beginning to decline.

Paints

It is estimated that approximately 1 % of the net UK imports of gum arabic annually find use in the paint industry.

Around 75 % of this quantity is used in the preparation of certain types of emulsions, and this market will decline as the relative popularity of these emulsions continues to decrease.

In its use as a binder in the preparation of water-colour paints, it is expected that substitution by dextrins will eventually take place, although very gradually, even in the high-quality paints. The market for gum arabic in this outlet has been greatly affected by substitutes: if no substitution had occurred, present demand would have been at least 150 tons annually, instead of the present 30–40 tons.

Therefore, demand in the paint industry can be expected to continue to decline at a gradual rate of 1–2 % per annum

United States of America

Imports are listed in Table 6 of the Appendix. Since 1962, the USA has established itself as the largest market in the world for gum arabic (apart from a freak occurrence in 1965 when the UK imported 22 tons more than the USA). The US market has generally increased over the years: there was a period of considerable growth in the late 1950s when imports rose to a peak of nearly 10 500 tons in 1959. This was followed by a decline, to 9 000 tons in 1962, and subsequent recovery to an average of 10 000 tons in 1963 and 1964. Growth continued, imports reaching 14 366 tons in 1967, from which height they fell back to an average of little more than 12 000 tons in the years 1968 to 1971. The average gross import over the years 1967–71 was approximately 13 000 tons.

There is a very marked preference for Sudanese gum in the United States, some 96 % of imports deriving from that source. However, in the last 2 or 3 years imports from alternative sources, particularly Nigeria, have increased. This may be the beginning of a move towards diversification of supplies, but as yet its significance is negligible.

Breakdown by area of use

Assuming a re-export norm of some 10 % of gross imports, the net US market for gum arabic over the last five years has averaged some 11 500 tons. An attempt has been made to analyse this market by area of use, but the information on which this analysis is based consists almost entirely of the informed comments of merchants in the US trade and several large users of gum arabic in the US. The analysis should therefore be treated with much caution.

About 65 % of net imports are used in edible products; with the soft drinks and the confectionery industry accounting for most of this percentage. A smaller, but significant outlet, is in the brewing industry, where perhaps 2 % of net imports is used. This 2 % could reduce the estimated market in either the confectionery or the flavour industry. The remaining percentage of gum imports is used in the pharmaceutical industry and a variety of technical uses such as lithography, adhesives, paints, the paper and wall-board industries and other minor outlets.

Confectionery

The US market differs from all other major markets in that as low a proportion as 30 % is used in confectionery. There is no particular reason for this except that traditional confections containing gum arabic do not have as strong a hold in the US market.

The US confectionery industry continues to expand, as it has done throughout the decade of the 1960s. The average annual rate of expansion in the second half of the 1960s was at least 2.5 % and 1969 per capita consumption reached a high of 9.1 kg per annum. The reasons for this expansion are the continuing growth of the US population, (at a rate of 1.3 % per annum in the years 1963–67) particularly the 10–19 age group, and a continuing growth in per capita incomes. It seems reasonable to assume that the confectionery industry in the USA will continue to grow at a rate of some 2.5 % per annum in the next few years.

The admittedly limited contact with the US confectionery industry strongly supports the view that modified starches are substituting for gum arabic in much the same way as in the UK. With a lack of any more precise information, it therefore seems reasonable to assume that the substitution rate will be similar to that in the UK, of the order of 5–10 % per annum. Therefore, allowing for the counteracting influence of the overall increase in the US confectionery industry (and assuming that this expansion, will result in a proportionate expansion in the demand for gum arabic), it is likely that the market for gum arabic in the US confectionery industry will decline by some 2.5–7.5 % per annum in the next few years.

Soft Drinks

An estimate for the use of gum arabic in the soft drinks industry has been given as 20 %. This is a large proportion and may err on the high side.

Soft drinks are the great growth sector in the American beverage industry. In the years 1964–69, sales of soft drinks rose by 9 % per annum, while sales of tea rose by only 3 % and sales of coffee actually fell by 1 % per annum. Thus, the large growth in sales of soft drinks can be attributed only partially to increases in population and per capita income. Much credit must be given to the promotional activities of the trade

The soft drinks trade expects the present rate of increase to continue for several years (one large soft drinks company estimated an increase of 10 % per annum in the future, and another estimated the future increase at 7 % per annum) and so, assuming a future growth rate of 9 % per annum, the derived demand for gum arabic should also continue to rise at 9 % per annum. There is no reason to assume that gum arabic will be substituted for in this use, but substitutes are available and the present rising prices and shortages of gum arabic can only have an adverse effect on the demand for it.

Spray-dried flavours

It is estimated that 10 % of net imports is used in the preparation of spray-dried flavours.

The increasing popularity of convenience foods has resulted in general expansion in the US food industry. Almost all such convenience foods (canned soups, frozen foods, snacks, etc) are flavoured with a prepared powder flavour, the flavour usually being sealed in by the spray-drying method. The flavour industry has been growing at an approximate annual rate of 7 % over the last few years and this trend is expected to continue.

Pharmacy

Little is known of the extent of use or the market trend of gum arabic in the pharmaceutical industry. Nevertheless the US industry has gone over to film-coated and capsule-type tablets to a greater extent than the UK and it is therefore likely US demand for gum arabic is falling.

Others

Gum arabic finds employment in many other fields, particularly lithography, adhesives, textiles and paper (where it is used mainly for sizing), and in the brewing industry. From the scant knowledge available on these various demands it seems reasonable to conclude that demand is declining in probably all of these fields, as substitutes take over. This is most certainly the case in the adhesives industry, where substitution has gone even further than in the UK, and also in the brewing industry where the use of gum arabic is now largely traditional, more efficient substitutes being available. In view of this it is estimated that the quantities of gum arabic used in these miscellaneous fields will decline at a rate of some 5–10 % per annum in the next few years.

France

Imports are listed in Table 7 of the Appendix. France is the third largest market for gum arabic, importing an average of some 8 100 tons over the period 1961–70. From an average of approximately 8 000 tons in the period 1957–62, a record import of 9 300 tons was recorded in 1963. Imports then fell gradually over the next four years, reaching a low of 7 350 tons in 1967. Between 1967 and 1970 imports recovered reaching 9 000 tons in 1970 but 1971 saw a downturn to 8 000 tons. With the gradual increase in re-exports in recent years, the net French market is declining. In 1971 re-exports reached the highest level for the period under review and accounted for 21 % of imports. Of the 2 100 tons re-exported in 1971 almost half went to other members of the EEC.

France continues to rely heavily on her former territories for the bulk of her imports. Imports from these countries remained remarkably stable over the period 1961–1970, averaging 58 % of the total and it seems likely this French reliance on these countries will continue as far as possible.

Sudan supplied one-third of French requirements up until 1968, with the exception of somewhat higher proportions in 1963 and 1964. From 1969, however, Sudanese supplies declined in importance to an average 23 % of the total market. This loss of Sudanese supplies to the market has been the gain of other suppliers, especially Mauritania and Senegal. Nigeria also significantly increased her imports to France between 1968 and 1970 to an average 14 % of the market. However, in 1971 this returned to 4 % a level similar to pre-1968 imports.

Breakdown by area of use

The net French market for gum arabic is at present around 6 900 tons based on figures for the years 1967–71. Information on the French market is scant and the following breakdown by area of use is based predominantly on the estimates given by one large French trader in gum arabic.

It is estimated that 60 % of net imports are used in the confectionery field, 10–15 % in pharmacy, 5 % in flavours, and 20–25 % in various technical uses, mainly lighography and adhesives.

Confectionery

The French confectionery industry has been expanding moderately over the past decade, at a rate of around 2 % per annum. Assuming this production increase to be reflected in the demand for gum arabic, and also assuming that substitution by dextrins in this field will take place but at a more gradual pace than in the US or the UK (since the French industry tends to be more traditional), then it is likely that the demand for gum arabic will remain stable or fall by perhaps 2 % or so per annum in the next few years.

Others

Nothing is known of the prospects for gum arabic in pharmacy and flavours, but it seems reasonable to assume that the rates of decline and growth respectively will be similar to those experienced in the UK. On the technical side, assuming for lack of a better criterion, that equal quantities are used in the adhesives and lithographic printing industries, it can be presumed that continued decline in the former will balance continued expansion in the latter. Therefore it is estimated that overall demand for gum in these technical outlets will at best remain stable.

Italy

Imports are listed in Table 8 of the Appendix. Italy provides the next largest market for gum arabic: from the mid-1950s to the early 1960s, the Italian market grew at a steady rate of some 4 % per annum, reaching 5 200 tons in 1963. Imports have increased considerably since 1963, but at a less steady rate, reaching 6 600 tons in 1970. Since the Italian market has only recently become a major one, it is unlikely that a significant re-export trade has been established.

The Sudan is the major supplier of gum arabic to the Italian market but her predominant position has been eroded in recent years by a rising interest in supplies from alternative origins. At their peak, in the period 1963–1966, Sudanese supplies accounted for an average 95 % of Italian imports. However after 1966 Sudanese supplies became less important although still accounting for 85 % of the Italian market. Between 1966 and 1970, the last year for which Italian statistics are available, the balance of the Italian demand was supplied by Nigeria, Senegal and France.

An interesting source of gum for Italy has traditionally been Iran, from whom Italy imported an average of some 250 tons per annum in the years 1957–62. Since that time, however, supplies from Iran have gradually fallen off and at the present time are negligible. This gum shiraz was used in the Italian textile industry, by the silk printers in the north of Italy. The reduction in this import suggests that superior substitutes have superseded gum arabic in this particular application.

Breakdown by area of use

Little is known of the Italian market: some gum arabic is used in the adhesives and the paint industries and, as in other countries, the gum is being consistently substituted for in these outlets. Similarly, it is being replaced in strictly pharmaceutical applications.

But by far the largest user of gum arabic in Italy is the confectionery industry: it is likely that as much as 75 % of annual gum arabic imports finds employment in this field. The rise in popularity of confections has been the prime reason behind the increase in the Italian market for gum arabic.

This increase in demand for confections is a result of the general growth of the Italian economy. Italy experienced relatively rapid economic growth in the late 1950s and the 1960s. In 1960 the per capita national disposable income was $650 (by 1970 this had risen to $1 592). With the economic growth providing higher real incomes, demands for semi-luxury goods such as confectionery increased. The confectionery industry expanded at a rate of as much as 10 % per annum over a period of years, but this rate of increase is now beginning to decline and a more moderate increase is expected in future years. The sales of gum-based confectionery are to a large extent independent of total confectionery sales, but they do appear to have risen at a similar rate. Thus, it may be expected that, with a more moderate future increase in total confectionery sales, the demand for gum arabic will rise accordingly at a rate of some 3–5 % per annum. However, as in other markets, substitution seems to be inevitable, in spite of the fact that more than one Italian manufacturer states that there is no visible substitute for gum arabic. Such views may mean that substitution with modified starches will be a more gradual process than in the UK or the US but even so, this, together with the decline in demand in the technical outlets, suggests that the best that can be hoped for is an increase in the total market of some 1 % or 2 % per annum.

The Netherlands

The Dutch market comes next in order of importance. Imports are listed in Table 9 of the Appendix. There was a definite increase in the market at the beginning of the 1960s, imports averaging 5 330 tons per annum in the years 1960–62. After 1962, imports fluctuated, reaching a low of 4 707 tons in 1964 and a high of 5 855 tons in 1968. But this latter figure was not maintained. Annual average imports between 1969 and 1971 were 4 800 tons.

The Dutch market is supplied predominantly from the Sudan. Sudan's share of the market was 75 % in the years 1960–62. Its share then fluctuated around an average of 73 % over the next four years, before dropping to 54 % in 1967. However, it quickly recovered to an average 69 % between 1968 and 1970, although in 1971 her share of the market declined to 45 %. It would appear therefore, that the Netherlands has marginally reduced its dependence on the Sudan.

Supplies of Nigerian gum to the Dutch market have varied widely. They were negligible in the mid-1960s but then gained in importance and accounted for 13 % of total supplies in 1969, only to virtually cease in 1970 and 1971.

Supplies from Senegal followed a similar pattern, never accounting for more than 2 % of total supplies until 1967, but maintaining higher levels thereafter. In 1970 and 1971 Senegalese gum accounted for 7 % and 12 % respectively of the Dutch market.

Like Italy, but to a greater extent, the Netherlands has relied on Iran as a large supplier of gum. Between 1960 and 1968 imports of gum shiraz ranged between 9 % and 24 % of total Dutch imports of gum arabic. In 1969 this share declined to 3 % but despite trade opinion that demand for the gum was decreasing, supplies from Iran significantly recovered in 1970 and 1971 respectively accounting for 19 % and 28 % of the market in those years.

The Netherlands also tends to import considerably larger than average quantities of gum tahl from the Sudan, although again the relative importance of this gum has greatly decreased: from 10 % in the years 1960–62, to an average of almost 5 % in the years thereafter. This inferior gum still has certain technical applications but it is likely that, in the years to come, the demand for it will continue to decrease as more efficient substitutes take over. The sole advantage of gum tahl at the present time is almost certainly its cheapness.

Breakdown by area of use

There is at the present time only one very important outlet for gum arabic in the Dutch market: the confectionery industry. However, gum arabic is used in adhesives, where the demand for it is declining as elsewhere, and in other technical uses, where it has already been noted that the demand for gum is declining fairly rapidly. It also finds some use in pharmacy and in the flavour industry, the latter still in its early stages, where perhaps 100 tons of gum arabic are used annually.

The confectionery use for gum arabic is very dominant, perhaps employing as much as 90 % of net Dutch imports. The great bulk of this quantity is used in the production of the traditional type of liquorice, which is very strong and is usually sold in the form of 'salted' rolls. The gum is also used in the making of wine gums, fruit gums and some kinds of peppermints.

Over the years the demand for gum arabic in this field must have been increasing, since the demand for gum shiraz and gum tahl has declined considerably and overall imports have remained fairly stable. This is borne out by contact with members of the Dutch confectionery industry, who claim that confections containing gum arabic are gaining in favour while the overall confectionery production stagnates. However, even assuming that the relative popularity of these confections continues to increase, the effect of substitution must be considered. Since the liquorice confection is so traditional, substitution with dextrins is likely to take place less rapidly, but contact with the trade confirms that such substitution has started and will continue at an increasing rate.

Therefore, assuming a reduction in demand for gum arabic as a result of substitution of some 5 % per annum, and a counterbalancing increase in demand for the confections containing it of perhaps 2 % per annum, it is likely that overall demand for gum arabic will fall at a rate of some 3 % per annum over the next few years. However, very much depends on the rate of substitution of dextrins for gum arabic in the traditional rolled liquorice.

German Federal Republic

Imports are listed in Table 10 of the Appendix. The gross German market for gum arabic has followed a rising trend. However, Germany is also a re-exporter of the product. Between 1961 and 1966 re-exports accounted for an average 16 % of total imports. In the five years 1967 to 1971 re-exports increased considerably and accounted for an average 27 % of total imports. The net market for gum arabic between 1961 and 1971 is shown below.

Net German imports of gum arabic (tons)

1961–63 annual average	1964–66 annual average	1967	1968	1969	1970	1971
3 379	3 873	3 486	3 453	3 400	3 683	3 621

Thus the net market for gum arabic reached a peak in the mid-1960s and since that time has stabilised around an annual average level of 3 530 tons.

The German Federal Republic traditionally purchases gum from a diversity of suppliers, although until 1971 the Sudan was still the major source. Between 1960 and 1964 Sudanese gum accounted for an average 59 % of the German market. Despite a rise in this proportion in the next two years, annual average imports declined to 44 % of the market in 1967 to 1970 and then decreased sharply to only 19 % in 1971.

Other suppliers to the German market are Nigeria and the former French West African states. German imports from Nigeria averaged only 6 % of total imports until 1966, then rose sharply from 11 % in 1966 to account for an average 24 % of the market between 1967 and 1971. Imports from Senegal have steadily increased and accounted for almost a third of the German market in 1971. Imports from Mali, Mauritania and Niger, normally negligible, were recorded as 4 % and 7 % respectively of total German imports in the years 1967 and 1969 but have not maintained their proportion of the market. The Federal Republic of Germany has successfully continued her policy of purchasing gum arabic from as wide a variety of suppliers as possible.

As with Italy and the Netherlands, Germany at one time purchased large quantities of gum from Iran, amounting to an average of 23 % of total imports in the years 1957–64. For the rest of the decade demand for this gum fell, but 1970 and 1971 saw some recovery in imports and Iran's share of the market rose from 6 % in 1970 to 13 % in 1971.

Breakdown by area of use

The major outlet for gum arabic in the German market is in the confectionery industry, where perhaps 60 % of net imports are used. Again, as in Holland, much of this is used in the liquorice-type confections. Because of the traditional nature of such confections it is unlikely that ingredients such as gum arabic will be replaced to a great extent in the near future. Nevertheless it is believed some gradual substitution for gum arabic by dextrins will take place, at a rate of perhaps 5 % per annum. At the present time the German confectionery industry is thriving and this expansion, if continued in future years, may reduce to a level of about 2 % per annum the rate at which demand for gum arabic in the industry is declining.

It is believed that perhaps 5–10 % of net imports are used as an emulsifier for soft drinks and a carrier for spray-dried flavours in the German flavour industry and that this demand will continue to expand at a rate of some 7 % per annum.

Another 10 % or so of imports is used in lithographic work and, extrapolating from the experiences of other markets, it can be assumed that this demand will rise by a maximum of 5 % per annum in the next few years.

The remaining 20–25 % of net imports are employed in pharmaceutical work (perhaps 5 %), and other technical fields and it is likely that the demand for gum arabic in these miscellaneous outlets will fall by some 5 % per annum.

India

Imports are listed in Table II of the Appendix. The Indian market for gum arabic has fallen steeply from the level of the mid-1950s, when an average of some 5 000 tons were imported annually. But following a short and sharp decline, Indian imports have stabilised around a mean annual figure of some 3 300 tons since the late 1950s.

The sharp decline from the high level of the mid-1950s principally affected exports from Tanzania; exports from the Sudan remained almost intact. Tanzanian supplies continued to decline in the late 1950s and early 1960s and are now negligible. With the decline of Tanzania as a source of supply, India now relies almost wholly on Sudan which provides around 99 % of total requirements.

The Indian demand is primarily for gum tahl, the inferior gum from *Acacia seyal.* In the late 1950s and early 1960s, India imported an annual average of over 500 tons of gum hashab, but the relative importance of hashab has declined and in the years 1967–71 imports averaged just over 100 tons per annum. India is the major market for Sudanese gum tahl: in the years 1961–65 India took an average of 62 % of Sudanese tahl exports, and in the years 1966–71 (with the exception of 1970 when no gum tahl was exported by the Sudan to India), the proportion increased to 73 %.

Breakdown by area of use

There is a considerable difference of opinion among experts in the gum arabic trade as to what India does with its supplies of gum arabic. It has been frequently suggested that, on arrival at Bombay, the gum is graded and the selected qualities are then re-exported. However, there is no statistical evidence to support this, although it is known that at one time quantities of Tanzanian gum arabic imported into India were graded on arrival and then re-exported.

The two main outlets for Indian imports of gum, would appear to be the textile trade, where gum arabic is used as a sizing agent and its use as a flocculent, mainly in the coconut oil industry. When the oil is expressed, it still contains certain impurities and to remove these a partial solution of tahl gum in water is floated on the top of the oil, whence it sinks to the bottom carrying the various impurities with it.

At the present time the Indian market for gum arabic appears to be fairly stable, if not slightly expanding and this situation is likely to continue in the foreseeable future. This is so because, considering the relatively low cost of gum tahl (although a 60 % duty obviously increases the cost considerably) and the lack of alternative demands for it, it is unlikely that synthetic or other substitutes will be sought to replace gum arabic in these particular applications.

Japan

Imports are listed in Table 12 of the Appendix. In the decade leading up to the early 1960s, Japanese imports of gum arabic increased at a faster rate than those of any other country – at approximately 7 % per annum. In a similar way to Italy, this was a consequence of general economic expansion from a relatively low level of wealth and activity. In 1963 Japanese national disposable per capita income was only $650 but by 1970 this had risen to $1 650. The Japanese economic boom has continued up to the present time, but the demand for gum arabic, although still on an increasing trend throughout the 1960s, has increased at a slightly slower rate. In the period 1961–1971 imports fluctuated about a rising trend, increasing from an average 2 200 tons per annum in the first half of the period to over 3 000 tons since 1969. Japan continues to rely on the Sudan for her supplies of gum, imports from that country normally averaging around 99 % of total annual imports.

Breakdown by area of use

There is not much information available on the areas of use in the Japanese market, but a crude estimate has been attempted, based wholly on opinion rather than fact. It is estimated that 30 % of imports are used in the confectionery industry, 25 % in the soft drinks field, 10 % in pharmacy, 20 % in lithography, and 15 % in various other, mostly technical, uses.

The Japanese confectionery industry continues to develop but any increased demand for gum arabic derived from this general expansion will be at least balanced by dextrin substitution. The Japanese are cost-conscious, do not have a longstanding tradition of preparing gum-containing confections, and so will readily substitute for gum arabic. It is therefore suggested that demand in this field will at best stagnate. The soft drinks industry is flourishing and with a rising population and incomes it is estimated that an increase of 10 % per annum will take place in this field. It is suggested that, as in other markets, the pharmaceutical demand will fall by some 5 % per annum. Again extrapolating from the experiences of other markets, the demand for gum arabic in lithographic printing could rise by as much as 5 % per annum, but it is perhaps more realistic to suggest that, with partial substitution, demand is likely to remain fairly stable. The miscellaneous uses being mostly technical, it is assumed that aggregate demand for gum arabic in these outlets will fall by about 5 % per annum.

Belgium-Luxembourg

Imports for the period 1961–71 are listed in Table 13 of the Appendix. With the exception of 1965 and 1968 imports did not exceed 2 000 tons and excluding these years have fluctuated about an annual average of 1 794 tons.

Belgium relies heavily on the Sudan as her major source of supply, although the figures suggest that this dependence is perhaps being lessened. In the years 1957–59, Belgium relied on the Sudan for only 57 % of her gum arabic imports (much of the rest being re-exports from other large markets), but this share rose to an average of 88 % in the next seven years, 1960–66. Since 1967 Sudanese supplies have fluctuated quite widely accounting for between 53 % and 81 % of the market. Supplies from Senegal have increased in significance since 1969 and in 1971 reached 341 tons, 21 % of the market.

Breakdown by area of use

Nothing is known of the end uses in the Belgian market and therefore a very crude simplification has been resorted to: namely, that the breakdown by area of use is similar to that of the French market. The trade statistics show a declining market since 1968. Whether this trend will continue is not known.

Australia

Imports are listed in Table 14 of the Appendix. Average annual quantities varied widely between 1960–61 and 1970–71 from 873 to 1 721 tons. Taking the last ten years shown, average imports of the two five-year periods up to 1970–71 have been 1 360 tons and 1 280 tons respectively. The market thus appears to be markedly stable. Australia also continues to rely almost totally on the Sudan for supplies.

On the basis of this scant information, it is therefore expected that the Australian market for gum arabic will decline at a rate of some 3–4 % per annum in the next few years because of substitution.

Breakdown by area of use

A large proportion of Australian imports, probably within the range 70–85 %, is used in the confectionery industry, mainly in the production of gums and pastilles. In recent years demand for gum in this field has been rather stable.

The Australian confectionery industry continues to expand, but at a modest annual rate of increase of less than 1 %. Confections containing gum arabic are holding their share of the market.

Although it would appear that dextrins have not yet had a large impact on the market for gum arabic, it seems inevitable that substitution will take place. Assuming an annual rate of substitution of 5 %, and allowing for a 1 % increase per annum in the demand for gum-type confections, it is likely that demand for gum arabic in the confectionery industry will fall by some 4 % per annum. The remaining 15–30 % of gum imports is used in various outlets. No detailed information on these is available.

South Africa

Imports are listed in Table 15 of the Appendix. The South African market for gum arabic has increased rather dramatically over recent years. From 410 tons in 1961 imports rose to 612 tons in 1964. In 1965 they rose very sharply to 2 148 tons. This high level was continued through 1966 and 1967, before imports fell back to 1 412 tons in 1968. From 1969 to 1971 imports averaged 1 318 tons per annum.

It is difficult to determine the relative importance of different suppliers to the South African market, since imports are recorded separately only from those countries which re-export gum to South Africa. It can be crudely estimated however, that Sudan supplies around 50 % of total imports and various re-exporting countries the other 50 %.

Breakdown by area of use

Little information is available, but it is suggested that a very large percentage of imports are for the expanding confectionery industry. The stabilising of imports at around 1 300 tons per annum after the short period when annual imports exceeded 2 000 tons may be the result, among other things, of dextrin substitution in the confectionery field.

Scandinavia

Under this heading, four countries are included: Denmark, Finland, Sweden and Norway.

Denmark

Imports are listed in Table 16 of the Appendix. Imports of gum arabic into Denmark followed a rising trend up to 1965 and then stagnated until 1968. Since 1968 the trade returns indicate some recovery in the market, initiated by a sharp rise in imports in 1969 of 1 750 tons; 1970 and 1971 imports were 1 381 tons and 1 418 tons respectively. Denmark continues to buy the bulk of her supplies from the Sudan but in recent years has taken significant quantities from Nigeria and Senegal, amounting to 247 and 124 tons respectively in 1971.

A large percentage, some 80–90 % of Danish imports, is used in the confectionery industry. Gum arabic is used mainly in the preparation of moulded liquorice pastilles and figures, which are increasing in popularity compared with other confections. Overall, confectionery production is expanding at a rate of a few percent per annum. However, dextrins are taking their toll and despite the increased potential demand for the above reasons, the demand for gum arabic in the Danish market is reported by trade sources to be falling because of rising prices for this material in relation to dextrins and other starches.

Finland

Imports are listed in Table 17 of the Appendix. Imports of gum arabic into Finland have followed a similar trend to the Danish. Annual average imports between 1960 and 1963 were 90 tons. The next three year average was 1 230 tons and then between 1967 and 1971 imports stabilised at an annual average of 1 560 tons. Sudan is the dominant supplier to the Finnish market. However, in 1971 imports from Israel of 252 tons were recorded.

The bulk of Finnish imports is used in the confectionery industry and again it is likely that dextrins will be increasingly substituted for gum arabic in this field. Although this would suggest a decline in the market, such a trend has not as yet occurred.

Sweden

Imports are listed in Table 18 of the Appendix. The Swedish market for gum arabic differs from the others in that it has been extremely stable over the years under review, averaging 1 130 tons over the period 1961–71. In the years 1967–71 imports varied between 891 and 1 245 tons. Sudan is the dominant supplier to the Swedish market.

Again, it is believed that the confectionery industry is by far the largest user of Swedish gum arabic imports but dextrins are already being substituted to a considerable degree and it is likely that future demand for gum arabic will continue to fall.

Norway

Imports are listed in Table 19 of the Appendix. The Norwegian market for gum arabic has also been very stable over the years, averaging 490 tons in the period 1961–1971. However, since 1969 imports have declined from 468 tons to 412 tons. For the same reasons as with Sweden, Norwegian imports are likely to fall.

Total Scandinavian market

The total Scandinavian market in 1970, the latest year when statistics from all four countries are available, was over 4 600 tons.

Other markets

Apart from the markets already discussed, there are a further 15 or so countries, who regularly import more than 100 tons per annum of gum arabic from the Sudan alone.

China is a relatively significant market for Sudanese gum arabic, importing an average of 1 000 tons from the Sudan in the years 1961–1971. This demand tends to fluctuate and after indications of a slight upward trend between 1964 and 1970, exports from the Sudan to China dropped to only 520 tons in 1971.

Imports into Hungary, Czechoslovakia and Poland from the Sudan fell to a low of 145 tons in 1970 from a 1965 peak of 800 tons. However, in 1971 the three countries imported over 700 tons of gum arabic, with Hungary accounting for 500 tons of this total.

Imports into Pakistan varied considerably between 1961 and 1971. A period of relative stability until 1963, with imports averaging 400 tons, was followed by severe fluctuations for the rest of the period. A phenomenal import of 3 500 tons in 1966 had not been equalled again by 1971. In 1971 itself imports were a mere 20 tons.

Between 1961 and 1971 Canadian annual imports remained in the range of 425 tons to 650 tons. The Sudan and the USA supplied together an average 94 % of imports.

In South America, Brazil received considerable quantities of gum arabic, averaging between 300 and 500 tons annually in the period 1961–1969. Supplies are predominantly from re-exporting countries, namely the German Federal Republic and the UK.

The Arab Republic of Egypt is a market of some signigicance and is also a re-exporter in some years. However, annual imports fluctuate widely and even when re-exports are taken into account, demand remains erratic. In the period 1961 to 1971 imports ranged between 110 tons and 930 tons.

The world market

The overall picture of world demand for gum arabic in recent years begins with a period of sustained growth in the late 1950s, culminating in 1960. A period of stagnation ensued, from 1961 to 1963, but was followed by renewed growth in

1964 and 1965. From 1966 up to the present time, demand has followed a slightly declining course, reaching the present level which, assuming normal conditions of supply, lies within the range 60–65 000 tons.

Summary of market conditons

It is clear that the demand for gum arabic in the various technical fields continues to decline as more efficient and/or less expensive substitutes continue to replace the often traditional gum arabic. The principal exception is the demand in the field of lithographic printing, which continues to expand. But there are efficient substitutes for gum arabic in this use and future difficulties in supply may rapidly curtail its demand in this industry.

The major cause of the estimated decline in the world market for gum arabic is, of course, the expected reduction in demand in the confectionery industry, where modified starches or dextrins are being substituted for the gum. Estimates have been made of the rate of takeover, but it is impossible to estimate this precisely. It depends on many factors, but particularly two: one is the rate of improvement in the technique of preparing dextrins, such that a more perfect substitute for the gum becomes available; the other is the future supply situation for gum arabic as continuing shortages will certainly increase the rate of substitution. But, whatever the rate of substitution of modified starches for gum arabic in the confectionery field, this substitution is taking place and will continue to do so.

There is one promising outlet for gum arabic which has become quantitatively significant only in recent years: the flavour industry. The industry uses gum arabic in the preparation of both spray-dried flavours and soft drinks. There are possible substitutes for the gum in this field but, provided the present situation of shortage is not prolonged, it is likely that gum arabic will continue to be the preferred material. With the rise in real incomes and the continuing trend towards convenience foods, the flavour industry is in an expansionary phase which should continue for many years and in which gum arabic can play an important role.

Part X

Prospects

The prospects for gum arabic in the major world markets continue to worsen. It has always been known that gum arabic has been open to sudden shortages of supply and concomitant rising prices. This state of affairs has caused considerable resentment in the major markets. Although this is by and large unjustified it is nevertheless real and has led many users to switch to substitutes.

Shortages and price increases

In 1973 the effects of the drought in the African countries south of the Sahara, where the main production belt lies, have led to a dearth of supplies and record prices for the gum. Fears that this situation of a 'creeping Sahara' may be permanent have meant that the Sudanese nationalised industry faces even greater pressure to ensure that the country's supplies can meet demand created by loss of production in the other West African countries. Production of good quality gum arabic seems to be limited to a well-defined geographical belt i.e. that land south of the Sahara, only about two hundred miles wide, stretching east from Mauritania and Senegal into the Sudan. Thus it is unlikely that countries outside this geographical area could offer potential areas for development of the production of gum arabic. Therefore major users of gum arabic are likely to look for substitutable materials rather than alternative sources of supply.

Despite the periodic shortages of gum arabic to major markets and the ever-widening range of substitutes available, gum arabic has been able to hold its own in some uses either because of its place as a traditional ingredient, e.g. in the confectionery industry or because of its superior performance to other materials, e.g. in lithography, water-colour paints and some adhesives. However, unless the price of gum arabic stops increasing it is to be expected that the costs of the material will outweigh the benefit and usage will cease.

Quality

The quality of gum arabic has also been criticised. Sudanese gum continues to be the best quality available but even so some buyers are unable to purchase the quality they want. The quality of supplies from other sources is considered inferior largely because the gum is not as well picked or selected as in the Sudan. Generally, in the West African countries there are no pure stands of *Acacia senegal*. The existence of mixed stands naturally tends to result in the collection of mixed lots of gum and this is largely responsible for the reputation for inferior quality which these gums possess. The solutions to this problem are twofold: one is to institute a more efficient selection process after the initial collection of the gum, so that the good bits of gum might be separated from the bad. This function is carried out with considerable success at the present time by various merchants, but it is an expensive process involving much labour and it is also very difficult to eliminate every single undesirable piece of gum.

Probably a better solution, therefore, is to institute a system of education so that the collectors of gum arabic can distinguish the preferred trees, presumably of the *Acacia senegal* species, and collect the gum only from these. Provided sufficient differential reward is offered to the collector for collecting only the preferred gum, or at least for keeping the different gums separate, then this policy should be successful. It should also be a cheaper alternative to the above policy of selection after collection.

A further factor contributing to the quality of the gum is the practice of tapping trees at all collection centres. It is also desirable the collectors are instructed in the proper method of tapping so that the parent trees are not harmed.

A final problem with supplies of gum arabic from sources other than the Sudan is that there is no way of ensuring that inferior lots of gum arabic are not exported. Even an occasional batch of inferior gum can establish, or consolidate, a bad reputation for all gum arabic from that particular source. Other things being equal, this is a strong reason for the establishment of a quality control system, perhaps similar to the Sudanese.

Processing at source

It has been suggested that any producer of gum arabic would benefit if the gum could be processed in the country of origin. However, several problems would appear to face suppliers who might be contemplating this move.

Firstly, many of the ultimate users of gum arabic, particularly those using major quantities, have their own processing facilities.

Secondly, processors at the source of supply would have to compete with the established processors in the importing countries. Thus the countries of origin would have to compete both with the fairly extensive skills and efficiency of these processors, apart from having to make an initial investment in equipment.

Thirdly, it would appear unlikely that the small price advantage that gum processed at source would have over gum processed in the importing countries could be sufficient to induce users to change their established channels of trade.

However, given that countries of origin could overcome these drawbacks and provide gum of acceptable quality, there would appear to be no reason why they could not perform this function efficiently.

Outlook

The outlook for gum arabic would appear, despite possible improvements in supply price and quality, to be one of slowly decreasing usage in the world's major markets. It is generally accepted that once substitution has taken place in any field, manufacturers never return to the old material as the replacement is usually consistently available and probably lower in price. However, given the decline of the market in North America and Europe, there may be reason to suppose that alternative and expanding markets could be found within the developing world and it is there that attention might be profitably diverted in the future.

References

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Appendix A

IMPORTERS OF GUM ARABIC

Note: The following list gives the names of some of the firms which are known to the Tropical Products Institute to be trading in this commodity, but the list should not be regarded as exhaustive. Inclusion in the list does not imply that TPI has any knowledge of the financial standing of the firms.

United Kingdom

Arthur Branwell & Co Ltd
Ibex House
43/44 Minories
London EC3

H. Frischmann
16 North End Road
London NW11

Hale & Son Ltd
Riverbank House
67 Upper Thames Street
London EC4

Hamburger & Sons
Tannery Lane
Send
Ripley Surrey

James Laing Ltd
(Kimpton Bros)
2 Chandos Street
London W1

Laing National
24 Mosely Street
Manchester 2

L. J. Rickards & Co
76 Watling Street
London EC4

Stewart, Robert & Sons Ltd
5 Milk Street
London EC2

A. F. Suter & Co Ltd
58 Mark Lane
London EC3

United Africa Co Ltd
United Africa House
Blackfriars Road
London SE1

G. C. Williams & Co
2 & 3 Philpot Lane
London EC3

Wynmouth Lehr & Fatoils Ltd
158 City Road
London EC1

United States

Agazarian Inc
11 Broadway
New York NY 10004

P. S. Busschaert Inc
Import and Export Agents
21 East 40th Street
New York NY 10016

Colony Import and Export Co
11 East 44th Street
New York NY 10017

P. L. Thomas & Co Inc
3013 Sixth Avenue
New York NY 10001

Meer Corporation
318 West 46th Street
New York NY 10036

George Uhe Co Inc
76 Ninth Avenue
New York NY 10011

France

A. Arnaud (OCODIS) SA
68 Avenue du General Michel Bizot
75 Paris 12e

IRANEX
350–356 Chemin du Littoral
13 Marseille (XVe)

Federal Republic of Germany

Cornhels and Bosse
2 Hamburg 11
Bei Den Muhren 91

C. E. Roeper
2000 Hamburg 13
Klosteralle 74

Ernst H. Singelmann
2000 Hamburg 11
Hopfensack 20

Italy

Carlo Erba
2015 Milano
Via Carlo Imbonati 24
Via Benigno Grespi 27
Casella Postale 3996

Netherlands

Stichting Import Arabische Gom
Marnixstraat 380
Amsterdam C

Japan

Gokyo Trading Co Ltd
12, 2-Chome
Fushimi-Machi
Higashi-Ku
Osaka

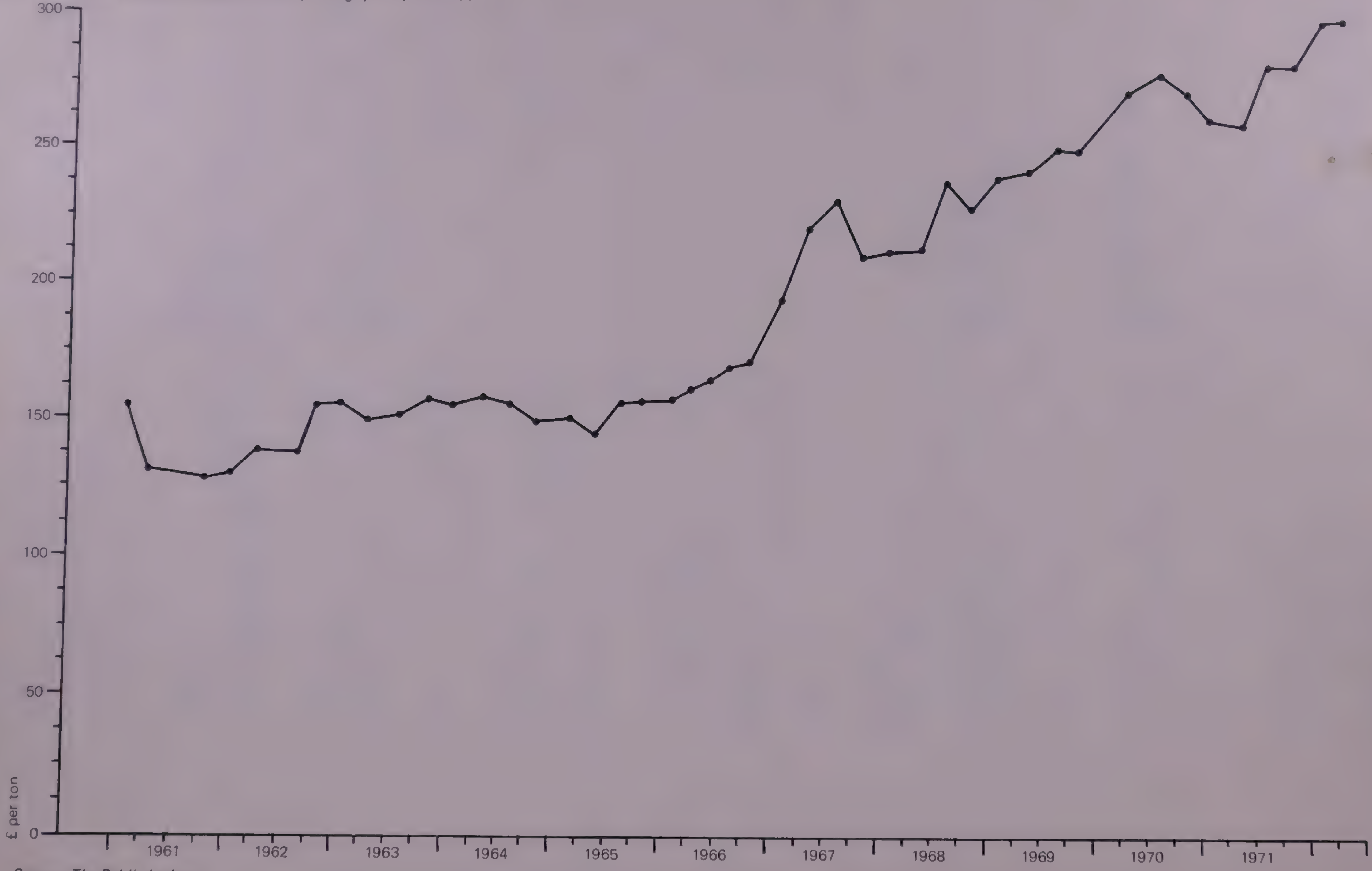
Iwaki and Co Ltd
1 Nihonbashi Honcho 4-Chome
Chuo-Ku
Tokyo 103

G. Shimizu & Co Ltd
3 1-Chome
Hirano Machi
Higashi-Ku
Osaka

Iwai & Co Ltd
43 Kitahama 4-Chome
Higashi-Ku
Osaka

Nagai-Ryu & Co Ltd
9, 4-Chome
Nihonbashi Hon-Cho
Chuo-Ku
Tokyo

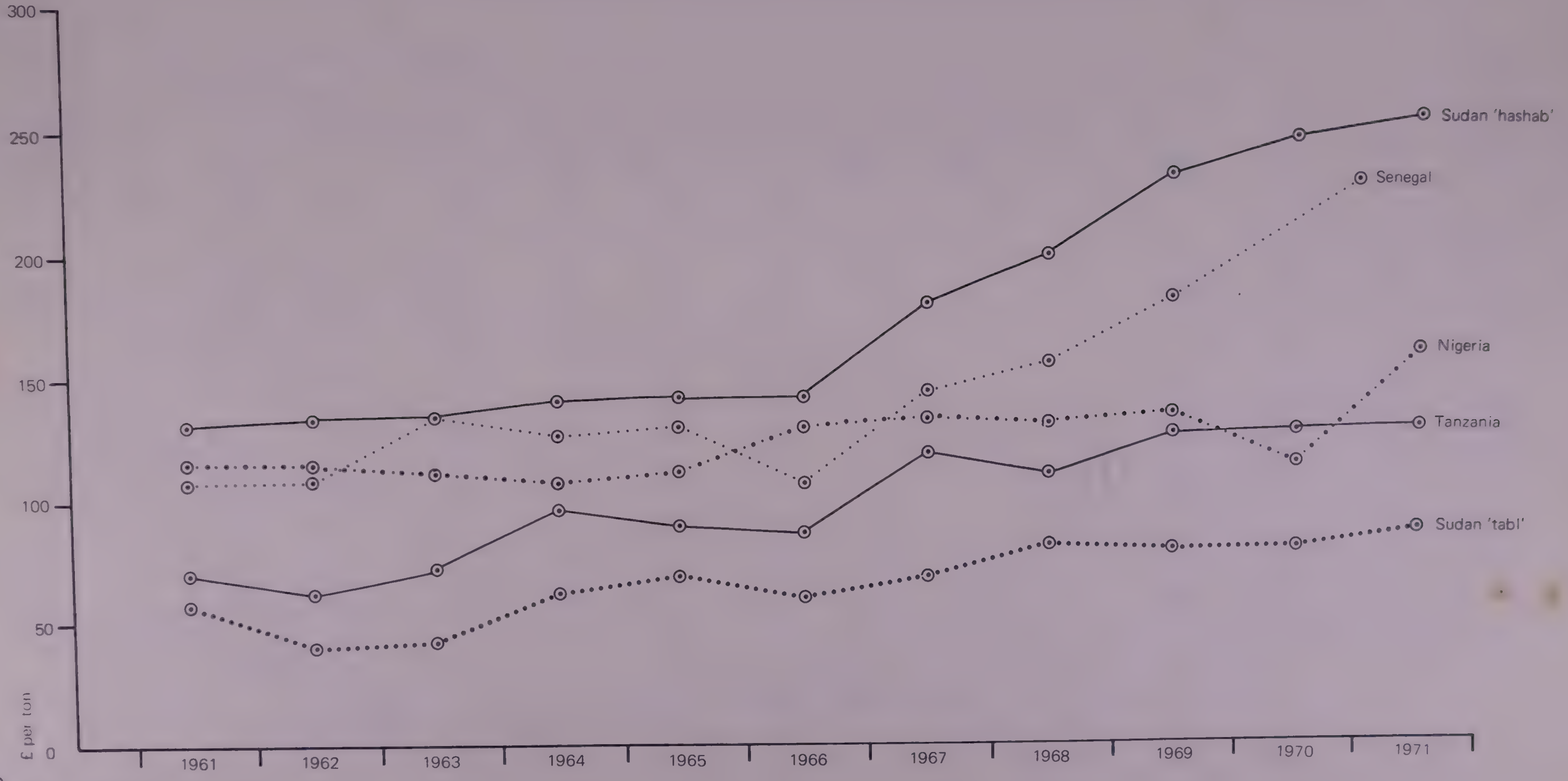
Figure I
Gum Arabic Kordofan Powder Quarterly average prices, cif London



Source: The Public Ledger

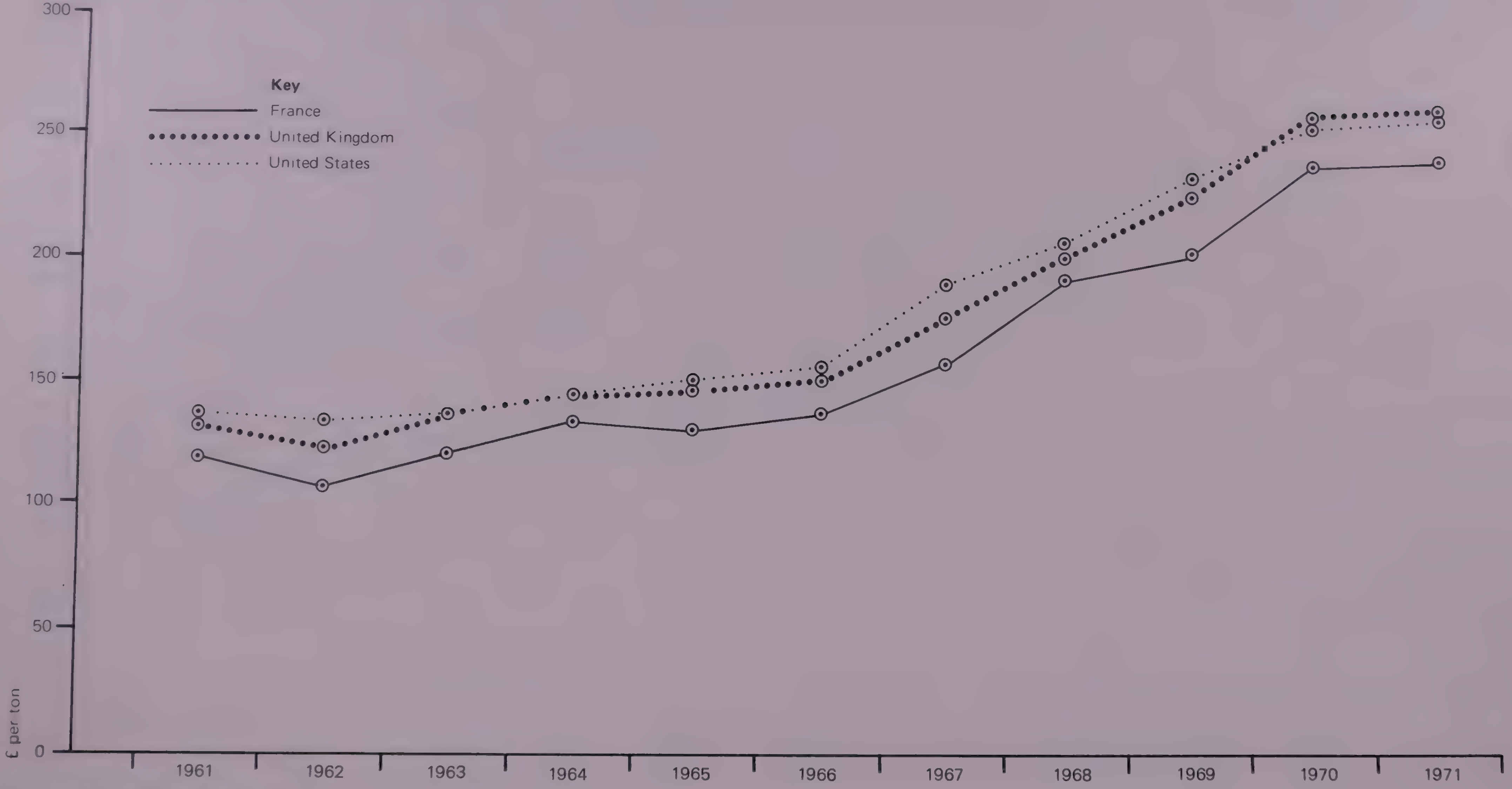
Figure II(a)

Gum Arabic Annual average values per unit quantity of exports from selected countries



Source: Official Trade Statistics

Figure II(b)
Gum Arabic Annual average values per unit quantity of imports into selected countries.



Source:— Official Trade Statistics

Table 1

Gum arabic: Exports from Producing Countries

Metric tons

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Sudan	'Hashab'	47 496	34 688	42 612	48 012	52 608	50 586	45 728	45 645	42 680	41 549	38 092
	'Tahl'	3 520	3 699	4 222	5 179	4 355	4 885	5 172	4 685	5 980	5 783	4 506
	'Dust'	143	320	217	397	590	360	777	406	375	457	518
	'Bleached'	84	39	64	50	46	48	51	—	121	53	—
	Total	51 243	38 746	47 115	53 638	57 599	55 879	51 728	50 736	49 156	47 842	43 116
West Africa (a) Recorded exports	Nigeria	2 627	2 101	2 655	2 627	2 644	2 656	4 432	3 854	4 203	4 933	2 546
	Senegal	2 131	2 405	146	1 016	2 216	1 038	3 207	3 985	7 070	9 415	. . .
	Mauritania	1 430	579	404	2 257	2 170	3 050	4 020	4 170	. . .	. . .	. . .
	Mali	340	776	641	243	175	110	410	170	260	. . .	. . .
	Niger	137	261	134	163	199	. . .	. . .	. . .	. . .	. . .	. . .
	Recorded total	6 665	6 122	3 980	6 306	7 404	. . .	. . .	. . .	. . .	. . .	. . .
(b) Imputed exports (derived from imports into 16 consuming countries)	Nigeria	4 254	3 443	3 336	2 572	3 889	3 728	5 018	5 054	5 882	4 994	(4 380)
	Senegal	1 441	2 645	2 329	1 760	2 555	1 436	4 822	2 888	3 235	5 513	(6 879)
	Mauritania	2 642	2 407	2 006	1 933	1 633	2 663	2 520	2 026	2 751	2 950	(2 576)
	Chad, Dahomey, Mali & Niger	1 026	969	803	848	453	849	1 444	1 084	1 140	787	(1 097)
	Imputed total	9 363	9 464	7 474	7 113	8 530	8 676	13 804	11 052	13 008	14 244	(14 932)
Tanzania	Total	535	762	802	466	426	629	480	188	402	512	376
World indigenous exports (thousand metric tons)		61.1	49.0	55.4	61.2	66.6	65.2	66.0	62.0	62.6	62.6	(58.4)

. . . Not available — Nil or negligible

( ) Partly estimated

Sources: Mainly official trade returns of exporting and importing countries. Imputed total for West Africa used for world total
Some figures from *Yearbook of International Trade Statistics FAO*

Table 2

Gum arabic (Hashab): Exports from Sudan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	47 496	34 688	42 612	48 012	52 608	50 586	45 728	45 645	42 680	41 549	38 092
	£'000	6 071	4 516	5 634	6 620	7 391	7 047	8 155	8 990	9 874	10 214	9 609
of which to:–												
Austria	M tons	84	6	2	140	141	60	40	168	25	–	–
	£'000	11	1	–	20	20	9	8	35	7	–	–
Belgium/Luxembourg	M tons	1 873	1 290	1 631	1 750	1 974	1 496	1 284	2 078	1 300	1 295	1 235
	£'000	235	164	215	239	275	215	248	409	291	315	306
Denmark	M tons	1 531	696	847	1 161	1 328	920	667	559	991	474	410
	£'000	193	89	111	160	185	128	111	111	229	114	101
Finland	M tons	999	898	884	1 082	1 459	1 161	1 083	1 333	1 087	1 340	815
	£'000	125	115	117	152	204	168	190	255	310	325	202
France	M tons	2 076	642	2 990	2 947	2 335	1 872	714	2 499	1 510	1 363	1 435
	£'000	265	82	382	403	320	270	120	456	348	342	359
German Federal Republic	M tons	3 271	1 404	1 517	1 846	1 967	1 154	1 052	1 590	2 576	2 338	1 605
	£'000	407	178	200	255	275	166	203	306	601	569	399
Greece	M tons	102	136	176	172	290	155	169	121	121	210	238
	£'000	13	19	23	25	43	24	34	26	29	52	60
Irish Republic	M tons	5	8	–	–	1	–	204	–	–	–	–
	£'000	1	1	–	–	–	–	31	–	–	–	–
Italy	M tons	4 575	4 408	5 019	5 426	5 456	6 195	5 345	5 382	5 217	4 639	4 108
	£'000	589	575	652	772	769	919	1 019	1 103	1 189	1 162	1 010
Netherlands	M tons	4 273	3 409	4 888	5 128	6 208	5 734	5 049	4 721	4 099	2 630	2 334
	£'000	533	429	627	686	824	787	810	857	924	636	579
Norway	M tons	497	396	465	304	484	422	337	422	489	406	355
	£'000	63	51	61	42	68	60	59	75	110	102	91

Table 2 (continued)

Gum arabic (Hashab): Exports from Sudan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Spain	M tons	11	25	356	290	399	352	311	352	381	363	268
	£'000	1	3	47	48	56	51	55	68	88	90	68
Sweden	M tons	1 209	1 329	742	515	1 305	775	985	951	985	1 011	1 075
	£'000	151	168	97	72	181	114	163	185	227	242	267
Switzerland	M tons	336	121	99	24	53	12	309	37	47	–	–
	£'000	42	15	14	3	7	2	63	7	11	–	–
Turkey	M tons	43	23	33	67	200	39	40	35	10	10	42
	£'000	6	3	4	10	29	5	5	7	2	3	11
United Kingdom	M tons	10 275	4 363	5 584	7 791	9 034	6 925	7 289	5 009	4 785	5 055	2 937
	£'000	1 300	554	729	1 057	1 252	990	1 261	1 019	1 100	1 237	729
Czechoslovakia	M tons	384	436	336	364	517	305	131	160	117	115	174
	£'000	50	58	48	56	77	49	22	33	27	30	41
German Democratic Republic	M tons	–	25	–	–	47	15	66	53	227	76	67
	£'000	–	3	–	–	6	2	13	11	13	18	16
Hungary	M tons	110	–	115	155	145	110	75	147	50	30	500
	£'000	13	–	16	22	20	16	14	31	12	8	125
Poland	M tons	229	127	195	172	156	–	132	–	–	–	30
	£'000	28	16	26	24	22	–	25	–	–	–	7
USSR	M tons	10	–	10	–	–	–	–	–	51	50	50
	£'000	1	–	1	–	–	–	–	–	12	14	13
Yugoslavia	M tons	3	103	74	2	80	20	51	32	111	207	110
	£'000	–	13	10	–	11	3	10	5	25	52	27
China	M tons	166	649	616	1 087	1 156	1 167	898	1 468	1 370	1 991	520
	£'000	20	83	79	152	169	171	187	294	339	476	130

Table 2 (continued)

Gum arabic (Hashab): Exports from Sudan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Hong Kong	M tons	290	151	257	226	207	192	99	286	131	180	127
	£'000	37	20	34	32	29	27	17	64	31	45	32
India	M tons	445	181	237	1 169	274	50	124	75	108	80	116
	£'000	58	23	21	21	41	7	24	16	20	24	31
Japan	M tons	1 966	2 138	2 341	2 085	2 312	2 386	2 806	2 588	2 720	2 905	3 238
	£'000	256	287	313	319	340	377	577	530	659	738	833
Pakistan	M tons	499	430	342	911	41	3 470	32	1	52	136	18
	£'000	63	56	45	137	6	213	5	–	12	36	4
Philippines	M tons	87	16	–	23	58	51	90	49	144	45	53
	£'000	11	2	–	3	8	7	17	8	13	11	13
Thailand	M tons	80	89	45	66	80	40	120	45	25	110	65
	£'000	10	11	6	9	11	6	24	8	6	28	16
Arab Republic of Egypt	M tons	717	564	238	122	684	562	120	113	765	111	486
	£'000	98	70	31	18	94	82	21	23	188	29	126
Morocco	M tons	53	–	5	–	–	–	–	–	–	–	–
	£'000	7	–	1	–	–	–	–	–	–	–	–
South Africa	M tons	402	294	413	–	–	–	–	–	–	–	–
	£'000	53	28	55	–	–	–	–	–	–	–	–
Argentine Republic	M tons	80	22	16	144	75	199	58	65	26	23	–
	£'000	11	3	2	21	11	29	11	14	6	6	–
Brazil	M tons	170	102	170	61	95	88	54	98	20	10	–
	£'000	24	14	23	9	14	13	10	20	5	3	–
Canada	M tons	205	244	315	338	340	288	220	218	274	251	233
	£'000	25	32	42	50	48	43	41	42	65	63	58

Table 2 (continued)

Gum arabic (Hashab): Exports from Sudan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Mexico	M tons	36	14	34	47	51	37	35	66	61	100	249
	£'000	5	2	5	7	7	5	7	12	14	26	61
United States	M tons	8 627	8 361	9 842	10 354	11 223	12 410	13 952	12 930	11 378	12 753	14 312
	£'000	1 129	1 131	1 336	1 492	1 621	1 804	2 420	2 534	2 635	3 139	3 670
Australia	M tons	1 162	1 070	1 177	1 340	1 537	1 195	1 284	1 465	1 054	868	546
	£'000	153	139	157	190	218	174	242	304	239	213	137
New Zealand	M tons	142	113	108	159	116	122	138	138	113	113	58
	£'000	19	15	15	23	17	19	28	31	26	29	15
Other Countries	M tons	473	405	493	544	781	607	365	392	260	261	283
	£'000	65	63	89	91	113	74	60	91	61	37	72

– Nil or negligible

Source: *Foreign Trade Report*
Dept. of Statistics

Table 3

Gum arabic (Kordofan): Quarterly Average Prices and Annual Range

(CIF London) £ per metric ton

		I	II	III	IV	Annual range	
						Low	High
Powder	1961	156	131	130	128	128	162
	1962	131	137	136	153	128	153
	1963	153	149	150	159	142	162
	1964	156	159	156	149	148	165
	1965	150	145	156	158	144	159
	1966	159	164	169	170	159	172
	1967	193	221	232	209	175	236
	1968	211	212	239	227	208	243
	1969	238	241	250	249	221	251
	1970	258	271	276	272	249	276
	1971	260	256	280	280	254	280
	1972	298	298				

Source: *The Public Ledger*

Table 4

Gum arabic: Imports into the United Kingdom

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	12 678	8 226	8 062	9 749	11 400	9 759	10 771	8 874	7 606	9 070	6 741
	£'000	1 651	1 009	1 091	1 392	1 646	1 439	1 879	1 762	1 692	2 310	1 736
of which from:–												
German Federal Republic	M tons	–	–	–	–	–	–	–	–	–	194	10
	£'000	–	–	–	–	–	–	–	–	–	50	3
Netherlands	M tons	44	22	14	22	55	28	–	34	16	11	67
	£'000	13	7	4	7	11	8	–	9	3	4	26
India	M tons	3	15	35	13	70	36	–	–	–	20	10
	£'000	–	2	10	2	12	5	–	–	–	10	4
Arab Republic of Egypt	M tons	–	–	5	10	–	5	88	60	120	48	30
	£'000	–	–	1	2	–	1	16	14	28	13	8
Chad	M tons	–	–	3	5	–	–	–	51	30	–	97
	£'000	–	–	–	1	–	–	–	9	2	–	16
Nigeria	M tons	3 236	2 908	2 526	2 078	2 660	2 284	2 413	2 287	1 680	2 472	1 470
	£'000	385	352	321	273	376	317	363	434	327	600	370
Senegal, Mali, Mauritania, etc.	M tons	5	81	–	–	–	50	712	742	577	1 331	1 816
	£'000	1	9	–	–	–	7	140	152	125	342	450
Sudan	M tons	9 280	5 013	5 298	7 456	8 552	7 334	7 409	5 645	5 116	4 851	2 967
	£'000	1 236	623	738	1 091	1 240	1 096	1 327	1 130	1 188	1 249	795
Tanzania	M tons	–	91	147	142	22	–	2	6	10	26	81
	£'000	–	9	14	13	2	–	–	1	2	4	14
United States	M tons	–	–	–	–	–	–	–	–	34	33	42
	£'000	–	–	–	–	–	–	–	–	13	14	18
Other Countries	M tons	110	96	34	23	41	22	147	49	53	84	151
	£'000	16	7	3	3	5	5	33	13	6	24	32

– Nil or negligible

Source: *The Trade of the United Kingdom*
HM Customs & Excise

Table 5

Gum arabic: Re-exports from United Kingdom

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	1 280	1 155	664	845	835	496	780	976	655	1 376	2 253
	£'000	198	168	114	152	149	104	146	238	180	424	669
of which to:–												
Belgium/Luxembourg	M tons	—	70	—	—	13	2	10	100	18	22	100
	£'000	—	9	—	—	3	1	3	25	6	9	27
German Federal Republic	M tons	—	—	—	—	9	29	166	50	29	—	40
	£'000	—	—	—	—	1	5	26	7	6	—	11
Irish Republic	M tons	119	124	169	165	125	46	70	158	23	140	190
	£'000	18	18	24	25	19	8	11	29	6	32	50
Netherlands	M tons	223	243	—	—	118	7	194	62	48	51	235
	£'000	28	30	—	—	17	1	24	13	11	17	71
Spain	M tons	60	—	—	—	55	3	13	12	9	18	66
	£'000	7	—	—	—	6	1	3	3	3	6	18
Ceylon	M tons	14	20	—	—	25	22	15	19	15	27	19
	£'000	3	6	—	—	7	6	4	7	4	11	8
Hong Kong	M tons	—	—	—	—	—	—	—	9	5	22	20
	£'000	—	—	—	—	—	—	—	2	2	8	8
Israel	M tons	73	—	—	—	11	18	20	28	24	18	36
	£'000	12	—	—	—	2	4	3	7	7	6	12
Philippines	M tons	—	—	—	—	2	2	7	34	5	34	17
	£'000	—	—	—	—	—	—	2	9	1	10	5
South Africa	M tons	22	83	59	126	210	95	65	105	40	101	294
	£'000	4	5	10	22	36	19	13	24	11	30	82
Thailand	M tons	—	—	—	—	6	14	11	19	20	18	31
	£'000	—	—	—	—	2	3	3	6	6	6	12

Table 5 (continued)

Gum arabic: Re-exports from United Kingdom

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Argentine Republic	M tons	34	–	–	77	31	15	27	28	53	73	51
	£'000	7	–	–	13	5	3	5	8	12	22	18
Brazil	M tons	–	–	–	–	12	20	4	28	8	63	76
	£'000	–	–	–	–	1	4	1	7	3	21	26
Canada	M tons	–	–	–	–	–	–	–	15	10	19	62
	£'000	–	–	–	–	–	–	–	3	3	6	16
Colombia	M tons	–	–	–	–	–	–	–	8	10	15	30
	£'000	–	–	–	–	–	–	–	2	3	5	10
Cuba	M tons	–	–	–	98	–	–	–	5	27	42	130
	£'000	–	–	–	18	–	–	–	1	7	13	39
Ecuador	M tons	40	–	–	–	–	–	–	–	9	19	34
	£'000	4	–	–	–	–	–	–	–	3	5	10
Mexico	M tons	21	31	–	–	26	24	25	43	19	31	4
	£'000	4	7	–	–	7	6	7	13	6	10	1
Peru	M tons	22	22	–	–	16	17	8	33	9	27	22
	£'000	5	4	–	–	3	4	2	10	3	10	9
United States	M tons	325	225	–	–	14	5	14	14	26	31	100
	£'000	44	26	–	–	1	1	3	4	6	8	25
Australia	M tons	30	41	–	–	30	31	15	40	165	223	232
	£'000	8	10	–	–	7	7	4	11	46	61	68
New Zealand	M tons	–	15	–	–	3	23	7	14	19	42	25
	£'000	–	3	–	–	1	5	2	4	5	15	10
Other countries	M tons	297	281	436	379	129	123	109	152	64	340	439
	£'000	54	50	80	74	10	26	30	43	20	113	133(a)

– Nil or negligible

(a) Including exports to France 79 metric tons
Valued £15 000
Finland 101 metric tons
Valued £24 000

Source: *The Trade of the United Kingdom*
HM Customs & Excise

Table 6

Gum arabic: Imports into the United States

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	9 335	9 090	10 052	9 970	11 378	12 635	14 366	11 608	12 133	12 283	13 517
	£'000	1 262	1 197	1 363	1 425	1 661	1 933	2 757	2 373	2 792	3 089	3 438
of which from:—												
India	M tons	—	—	—	—	5	55	276	—	—	45	18
	£'000	—	—	—	—	1	9	49	—	—	11	5
Liberia	M tons	—	—	—	—	—	20	—	60	—	—	—
	£'000	—	—	—	—	—	3	—	14	—	—	—
Madagascar	M tons	—	—	—	—	—	—	55	—	—	—	—
	£'000	—	—	—	—	—	—	12	—	—	—	—
Nigeria	M tons	46	131	15	42	40	15	119	159	270	30	177
	£'000	6	16	2	5	3	2	23	33	63	7	45
Senegal	M tons	—	—	—	—	34	127	266	235	10	25	696
	£'000	—	—	—	—	5	18	45	49	2	7	180
Sudan	M tons	9 167	8 820	9 907	9 820	11 251	12 277	13 981	11 126	11 740	12 085	12 419
	£'000	1 238	1 161	1 346	1 407	1 644	1 876	2 615	2 270	2 701	3 047	3 158
Canada	M tons	14	3	1	25	9	49	14	—	—	—	—
	£'000	4	1	—	2	3	11	3	—	—	—	—
Other Countries	M tons	108	136	129	83	39	92	345	28	113	98	207
	£'000	14	19	15	11	5	14	10	7	26	17	50

— Nil or negligible

Source: *Bureau of the Census Report FT 110*
Department of Commerce

Table 7

Gum arabic: Imports into France

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	8 560	6 898	9 319	8 525	7 899	7 755	7 343	7 701	8 135	9 029	7 900
	£'000	1 002	721	1 123	1 131	1 042	1 041	1 144	1 454	1 635	2 136	2 532
of which from:—												
German Federal Republic	M tons	—	—	—	—	—	—	20	101	74	53	41
	£'000	—	—	—	—	—	—	4	21	19	16	19
India	M tons	—	—	—	—	—	—	—	61	—	29	—
	£'000	—	—	—	—	—	—	—	18	—	11	—
Chad	M tons	177	608	446	603	380	364	514	476	236	275	142
	£'000	23	66	58	89	54	53	86	92	46	66	51
Mali	M tons	790	305	354	240	—	39	249	169	346	274	387
	£'000	75	32	42	27	—	6	38	34	69	66	118
Mauritania	M tons	2 642	2 392	2 006	1 933	1 633	2 663	2 259	1 949	2 433	2 900	2 435
	£'000	332	278	265	287	225	367	380	375	498	716	796
Niger	M tons	41	—	—	—	34	199	371	305	241	161	69
	£'000	5	—	—	—	5	29	55	56	44	39	20
Nigeria	M tons	646	154	395	193	461	605	374	1 000	1 422	986	331
	£'000	57	9	34	15	43	70	46	182	287	161	65
Tanzania	M tons	—	63	348	163	164	198	197	72	127	69	94
	£'000	—	4	24	19	19	21	23	12	18	8	19
Senegal	M tons	1 325	1 656	2 127	1 535	2 348	1 025	1 864	877	1 414	1 937	2 595
	£'000	169	192	276	228	328	145	325	170	289	491	824
Sudan	M tons	2 805	1 676	3 622	3 775	2 830	2 622	1 469	2 634	1 778	2 284	1 746
	£'000	326	133	419	458	359	336	181	483	350	536	583
United States	M tons	—	—	—	—	—	—	—	53	12	34	—
	£'000	—	—	—	—	—	—	—	11	5	17	—
Other Countries	M tons	134	44	18	83	49	40	26	4	52	27	60
	£'000	15	7	5	8	9	14	6	—	10	9	37

— Nil or negligible

Source: *Commerce Exterieur*
Direction Generale Des Douanes Et Droits Indirectes

Table 8

Gum arabic: Imports into Italy

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Totals	M tons	4 771	4 753	5 203	4 875	5 673	6 111	5 065	6 454	5 729	6 571
	£'000	695	676	762	775	876	919	953	1 357	1 315	1 644
of which from:—											
Belgium/Luxembourg	M tons	—	—	—	—	—	—	—	—	—	10
	£'000	—	—	—	—	—	—	—	—	—	8
France	M tons	60	75	19	45	23	11	29	303	224	330
	£'000	10	11	5	10	6	1	5	64	49	85
German Federal Republic	M tons	13	19	41	33	16	10	8	11	34	28
	£'000	6	6	12	10	2	3	2	2	11	10
United Kingdom	M tons	4	3	2	11	5	1	15	12	20	1
	£'000	1	1	2	6	3	—	5	3	7	1
India	M tons	55	35	42	31	29	7	—	1	—	—
	£'000	16	10	14	13	12	3	—	—	—	—
Iran	M tons	251	128	140	81	91	44	17	1	—	—
	£'000	75	57	50	62	64	21	12	1	—	—
Arab Republic of Egypt	M tons	—	—	10	10	—	—	—	—	—	110
	£'000	—	—	1	2	—	—	—	—	—	31
Dahomey	M tons	—	—	—	—	—	—	—	—	—	70
	£'000	—	—	—	—	—	—	—	—	—	19
Mauritania	M tons	—	15	—	—	—	—	61	16	3	50
	£'000	—	2	—	—	—	—	13	3	1	12
Nigeria	M tons	10	20	12	31	12	8	178	88	154	77
	£'000	1	1	1	2	1	1	36	18	35	17
Senegal	M tons	29	188	15	10	23	30	494	119	228	309
	£'000	4	23	2	1	3	5	97	27	55	78
Sudan	M tons	4 193	4 217	4 896	4 615	5 447	5 878	4 166	5 858	5 014	5 407
	£'000	563	555	670	668	778	864	765	1 222	1 144	1 346
United States	M tons	—	—	—	1	2	7	—	7	3	37
	£'000	—	—	—	—	1	4	—	3	1	18
Other Countries	M tons	156	53	26	7	25	114	97	38	49	142
	£'000	19	10	5	1	6	17	18	4	12	19

Table 9

Gum arabic: Imports into The Netherlands

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	5 662	5 520	5 394	4 707	5 413	5 580	5 267	5 855	5 055	4 421	4 958
	£'000	741	673	730	672	780	816	901	1 119	1 125	980	1 223
of which from:—												
France	M tons	51	—	197	6	9	9	103	178	144	52	291
	£'000	10	—	26	2	3	2	20	29	36	17	81
German Federal Republic	M tons	62	48	64	91	13	79	41	63	28	31	194
	£'000	9	7	12	16	5	12	11	15	11	8	53
United Kingdom	M tons	224	268	104	183	51	18	248	177	89	76	196
	£'000	32	36	18	26	12	8	45	43	21	26	64
Iran	M tons	803	825	1 306	426	1 208	1 037	951	807	161	825	1 399
	£'000	145	96	191	79	199	166	140	146	41	117	265
Arab Republic of Egypt	M tons	—	—	—	—	—	204	—	—	—	—	—
	£'000	—	—	—	—	—	30	—	—	—	—	—
Nigeria	M tons	—	—	—	—	55	113	256	126	649	—	42
	£'000	—	—	—	—	7	16	48	22	143	—	9
Senegal	M tons	—	326	50	99	99	85	741	322	297	320	611
	£'000	—	40	7	13	14	12	145	63	69	87	156
Sudan	M tons	4 441	3 886	3 626	3 824	3 931	3 961	2 869	3 996	3 558	3 100	2 219
	£'000	534	472	469	525	531	555	478	762	779	721	592
United States	M tons	—	—	—	—	2	4	1	17	4	8	4
	£'000	—	—	—	—	2	2	2	9	4	4	2
Other Countries	M tons	81	167	47	178	45	70	57	169	125	9	2
	£'000	11	22	7	11	7	13	12	30	21	—	1

— Nil or negligible

Source: *Maandstatistiek Van De In-uit-Voer*
Centraal Bureau Voor De Statistick

Table 10

Gum arabic: Imports into the German Federal Republic

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	4 163	3 594	4 478	4 520	4 712	4 535	4 503	4 974	4 815	5 223	4 888
	£'000	673	607	755	820	662	664	784	940	1 068	1 269	1 161
of which from:–												
France	M tons	31	54	–	–	25	36	31	62	21	34	31
	£'000	7	13	–	–	2	3	3	13	2	5	6
Switzerland	M tons	–	–	–	–	–	–	–	–	–	–	40
	£'000	–	–	–	–	–	–	–	–	–	–	12
United Kingdom	M tons	18	35	30	33	14	25	16	13	–	–	59
	£'000	2	5	4	5	2	4	4	2	–	–	17
India	M tons	251	367	372	389	32	51	65	111	100	101	167
	£'000	52	79	93	100	6	10	12	22	22	28	54
Iran	M tons	616	780	909	1 064	164	126	208	542	199	293	641
	£'000	185	202	233	287	19	11	18	63	24	38	102
Chad	M tons	18	46	–	10	39	247	310	83	262	77	97
	£'000	2	5	–	2	6	44	59	14	61	16	24
Mauritania	M tons	–	–	–	–	–	–	200	11	315	–	–
	£'000	–	–	–	–	–	–	39	2	74	–	–
Niger	M tons	–	10	–	–	–	–	–	–	–	–	75
	£'000	–	1	–	–	–	–	–	–	–	–	19
Nigeria	M tons	195	141	352	218	530	506	1 329	921	1 415	1 087	1 047
	£'000	25	16	48	31	72	74	223	173	319	275	242
Senegal	M tons	22	141	55	24	39	25	552	445	345	1 147	1 557
	£'000	3	18	7	4	6	4	109	93	80	305	395
Sudan	M tons	2 944	1 905	2 598	2 685	3 761	3 272	1 537	2 694	1 922	2 339	941
	£'000	384	249	350	377	536	483	278	538	441	575	246
Tanzania	M tons	–	–	60	17	64	196	153	59	188	110	147
	£'000	–	–	6	2	8	23	22	11	31	18	23
Other Countries	M tons	68	115	102	80	44	51	102	33	48	35	86
	£'000	13	19	14	12	5	8	17	9	14	9	21

– Nil or negligible

Source: *Der Aussenhandel*
Statistisches Bundesamt

Table 11

Gum arabic: Imports into India

		*1960–61	1961–62	1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69	1969–70	1970–71
Totals	M tons	4 813	2 184	2 406	2 592	3 874	3 205	3 260	3 571	3 294	3 972	4 448
	£'000	616	269	318	152	276	238	201	302	277	339	404
of which from:–												
Kenya	M tons	55	19	18	–	–	–	–	–	–	–	–
	£'000	9	3	2	–	–	–	–	–	–	–	–
Sudan	M tons	3 194	1 721	2 159	2 419	3 852	3 163	3 230	3 537	3 282	3 958	4 429
	£'000	482	201	282	135	272	233	200	299	275	337	401
Tanzania	M tons	739	376	222	166	12	35	6	10	–	–	–
	£'000	109	57	33	16	1	4	1	–	–	–	–
Other Countries	M tons	825	68	7	7	10	7	24	24	12	14	19
	£'000	16	8	1	1	3	1	–	3	2	2	3

* Fiscal year 1 April–31 March

– Nil or negligible

Source: *Foreign Trade of India*
Dept. of Commercial Intelligence and Statistics

Table 12

Gum arabic: Imports into Japan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	2 094	2 136	2 165	2 407	2 240	2 690	2 842	2 510	3 174	3 185	3 355
	£'000	298	307	315	390	366	439	604	570	788	842	965
of which from:–												
German Federal Republic	M tons	–	–	–	–	–	–	–	51	94	66	98
	£'000	–	–	–	–	–	–	–	19	37	25	44
Hong Kong	M tons	–	–	–	–	–	–	–	–	–	–	20
	£'000	–	–	–	–	–	–	–	–	–	–	6
Sudan	M tons	2 075	2 113	2 156	2 392	2 223	2 646	2 821	2 445	3 060	3 113	3 229
	£'000	290	302	312	383	363	432	599	548	744	815	911
United States	M tons	3	3	3	1	6	3	13	4	8	5	7
	£'000	1	1	1	–	2	1	5	2	4	2	4
Other Countries	M tons	16	20	6	14	11	41	8	10	12	1	1
	£'000	7	4	2	7	1	6	–	1	3	2	–

– Nil or negligible

Source: *Trade of Japan*
Japan Tariff Association

Table 13

Gum arabic and Tragacanth: Imports into Belgium/Luxembourg

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	1 960	1 691	1 683	1 965	2 198	1 881	1 571	2 247	1 982	1 802	1 610
	£'000	258	226	239	291	323	280	312	476	477	518	429
of which from:–												
France	M tons	–	–	–	–	–	–	–	–	–	–	151
	£'000	–	–	–	–	–	–	–	–	–	–	46
German Federal Republic	M tons	–	–	–	–	–	–	–	41	–	–	–
	£'000	–	–	–	–	–	–	–	11	–	–	–
United Kingdom	M tons	–	–	–	–	–	–	–	68	–	–	78
	£'000	–	–	–	–	–	–	–	20	–	–	22
Nigeria	M tons	–	–	–	–	–	–	120	135	–	–	–
	£'000	–	–	–	–	–	–	24	27	–	–	–
Senegal	M tons	–	144	–	–	–	–	–	18	278	299	341
	£'000	–	18	–	–	–	–	–	4	81	126	86
Sudan	M tons	1 862	1 389	1 565	1 632	1 988	1 648	1 143	1 824	1 324	1 345	848
	£'000	239	181	212	234	285	243	222	376	304	340	220
Other Countries	M tons	98	158	118	333	210	233	308	161	380	158	192
	£'000	19	27	27	57	38	37	66	38	92	52	55

– Nil or negligible

Source: *Commerce Exterieur*
L'Institut National de Statistique

Table 14

Gum arabic: Imports into Australia

12 months ending 30th June of year shown		1960–61	1961–62	1962–63	1963–64	1964–65	1965–66	1966–67	1967–68	1968–69	1969–70	1970–71
Totals	M tons	1 657	1 070	1 291	1 341	1 721	1 366	1 290	1 257	1 914	873	1 084
	£'000	252	140	179	189	253	206	212	274	435	224	292
of which from:–												
United Kingdom	M tons	–	–	–	–	–	35	–	29	51	70	82
	£'000	–	–	–	–	–	6	–	9	16	21	24
Nigeria	M tons	25	–	–	–	–	–	–	–	–	37	30
	£'000	3	–	–	–	–	–	–	–	–	9	7
Sudan	M tons	1 562	1 022	1 239	1 328	1 633	1 314	1 270	1 211	1 782	736	922
	£'000	234	130	170	186	239	197	207	261	400	178	237
United States	M tons	–	–	–	–	–	–	–	–	–	25	38
	£'000	–	–	–	–	–	–	–	–	–	13	20
Other Countries	M tons	70	48	52	13	88	17	20	17	81	5	12
	£'000	15	10	9	3	14	3	5	4	19	3	4

– Nil or negligible

Source: *Overseas Trade*
Commonwealth Bureau of Census and Statistics

Table 15

Gum arabic: Imports into South Africa

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	410	418	465	612	2 148	2 112	2 173	1 412	1 171	1 384	1 389
	£'000	59	59	64	97	396	393	372	315	374	373	416
				(a)	(a)						(a)	(a)
of which from:–												
German Federal Republic	M tons	–	–	. . .	. . .	69	92	98	110	93	. . .	. . .
	£'000	–	–	. . .	. . .	23	23	27	37	38	. . .	. . .
Greece	M tons	–	–	. . .	. . .	–	–	–	–	200	. . .	. . .
	£'000	–	–	. . .	. . .	–	–	–	–	16	. . .	. . .
Netherlands	M tons	–	–	. . .	. . .	264	289	65	–	–	–	–
	£'000	–	–	. . .	. . .	61	67	15	–	–	–	–
Portugal	M tons	–	–	. . .	. . .	531	452	539	264	324	. . .	. . .
	£'000	–	–	. . .	. . .	46	32	36	21	30	. . .	. . .
United Kingdom	M tons	5	8	. . .	. . .	180	96	136	122	115	. . .	. . .
	£'000	1	2	. . .	. . .	54	44	57	51	60	. . .	. . .
Sudan	M tons	374	395	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
	£'000	51	53	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
United States	M tons	25	12	. . .	. . .	192	276	356	244	243	. . .	. . .
	£'000	6	3	. . .	. . .	34	41	32	41	33	. . .	. . .
Other Countries	M tons	6	3	465	612	1 092	907	979	672	196	1 384	1 389
	£'000	1	1	64	97	178	186	205	165	197	373	416

(a) Breakdown not available
. . . Information not shown
– Nil or negligible

Source: *Foreign Trade Statistics*
Dept. of Customs & Excise

Table 16

Gum arabic: Imports into Denmark

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	1 043	973	807	1 138	1 313	1 165	1 019	1 296	1 751	1 387	1 418
	£'000	146	128	113	169	194	174	177	273	364	364	369
of which from:–												
German Federal Republic	M tons	12	22	35	11	9	12	28	74	85	73	109
	£'000	2	4	5	2	2	2	6	18	22	20	30
Iceland	M tons	–	–	–	–	52	–	–	–	–	–	–
	£'000	–	–	–	–	6	–	–	–	–	–	–
Portugal	M tons	–	–	–	–	–	25	27	5	20	–	40
	£'000	–	–	–	–	–	2	2	–	2	–	6
United Kingdom	M tons	43	51	7	17	6	16	17	12	72	42	16
	£'000	6	8	3	5	2	4	4	5	18	11	4
China	M tons	–	–	–	–	–	–	–	–	5	–	81
	£'000	–	–	–	–	–	–	–	–	–	–	11
Saudi Arabia	M tons	–	–	–	27	14	–	–	–	4	3	–
	£'000	–	–	–	4	2	–	–	–	1	1	–
Mali	M tons	77	65	–	–	–	–	–	–	–	–	–
	£'000	10	8	–	–	–	–	–	–	–	–	–
Nigeria	M tons	–	–	–	5	67	103	160	167	183	183	247
	£'000	–	–	–	1	10	15	28	32	43	45	65
Senegal	M tons	–	8	–	2	–	10	141	164	35	79	124
	£'000	–	1	–	–	–	1	28	38	8	21	33
South Africa	M tons	–	–	–	50	10	–	–	–	–	–	–
	£'000	–	–	–	7	2	–	–	–	–	–	–
Sudan	M tons	903	799	738	1 014	1 147	980	607	827	1 325	984	783
	£'000	126	103	101	148	169	146	101	164	237	257	214
United States	M tons	–	5	7	6	4	8	5	20	6	10	5
	£'000	–	1	1	1	1	2	1	6	2	5	2
Other Countries	M tons	8	23	20	6	4	11	34	27	16	13	13
	£'000	2	3	3	1	–	2	7	10	31	4	4

– Nil or negligible

Source: *Foreign Trade of Denmark*
Det Statistiske Departement

Table 17

Gum arabic: Imports into Finland

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Totals	M tons	1 019	970	976	1 156	1 321	1 210	1 543	1 590	1 533	1 588
	£'000	143	136	140	176	203	193	274	334	377	432
of which from:–											
German Federal Republic	M tons	–	–	3	1	–	3	10	30	–	9
	£'000	–	–	1	–	–	1	2	7	–	3
Israel	M tons	–	–	138	–	–	–	–	5	–	252
	£'000	–	–	20	–	–	–	–	1	–	68
Gabon	M tons	–	–	–	–	50	–	–	–	–	–
	£'000	–	–	–	–	8	–	–	–	–	–
Nigeria	M tons	–	–	–	–	–	45	28	31	1	17
	£'000	–	–	–	–	–	7	45	6	–	5
Senegal	M tons	–	–	–	–	–	–	5	1	36	34
	£'000	–	–	–	–	–	–	1	–	9	10
Sudan	M tons	1 005	969	834	1 154	1 221	1 159	1 242	1 519	1 457	1 261
	£'000	141	135	119	176	187	184	224	318	358	344
Other Countries	M tons	14	1	1	1	50	3	258	4	39	15
	£'000	2	1	–	–	8	1	2	2	10	2

– Nil or negligible

Source: *Foreign Trade*
Official Statistics of Finland

Table 18

Gum arabic: Imports into Sweden

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	1 373	1 334	790	1 042	1 196	1 197	1 088	1 103	891	1 183	1 245
	£'000	194	177	110	156	182	185	195	222	205	310	340
of which from:–												
German Federal Republic	M tons	–	–	6	9	5	17	11	8	15	13	8
	£'000	–	–	1	2	1	3	2	2	4	4	3
Netherlands	M tons	3	–	–	6	4	11	9	8	10	10	3
	£'000	1	–	–	2	1	3	3	4	4	4	1
United Kingdom	M tons	2	–	3	7	11	13	8	4	8	5	5
	£'000	1	–	1	2	2	3	2	1	2	2	1
Nigeria	M tons	–	–	–	–	25	36	20	75	78	56	44
	£'000	–	–	–	–	4	5	4	15	17	15	12
Senegal	M tons	30	47	21	23	14	69	42	15	15	17	17
	£'000	4	6	3	3	2	11	8	3	4	5	4
Sudan	M tons	1 328	1 275	721	960	1 106	1 032	969	988	753	1 073	1 151
	£'000	187	169	100	141	166	157	173	195	171	278	313
United States	M tons	–	7	12	16	3	11	3	–	–	–	–
	£'000	–	1	2	3	1	2	1	–	–	–	–
Other Countries	M tons	10	5	27	21	28	8	26	5	12	9	17
	£'000	1	1	3	3	5	1	2	2	3	2	6

– Nil or negligible

Source: *Sveriges Inforsel Och Utforsel*
Statistiska Centralbyrån

Table 19

Gum arabic: Imports into Norway

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	573	586	579	363	529	513	353	577	468	446	412
	£'000	79	78	80	55	81	80	67	128	110	124	119
of which from:–												
Portugal	M tons	30	–	31	–	–	–	–	–	–	–	–
	£'000	4	–	2	–	–	–	–	–	–	–	–
United Kingdom	M tons	–	–	14	–	–	17	13	10	18	12	7
	£'000	–	–	2	–	–	4	3	3	6	4	3
Nigeria	M tons	25	58	–	–	–	–	21	–	–	–	–
	£'000	2	5	–	–	–	–	4	–	–	–	–
Sudan	M tons	505	498	508	349	508	477	311	538	388	423	395
	£'000	70	67	71	53	77	72	57	115	88	116	112
Other Countries	M tons	13	30	26	14	18	19	8	29	62	11	10
	£'000	3	6	5	2	4	4	3	10	16	4	4

– Nil or negligible

Source: *Foreign Trade of Norway*
Statistisk Sentralbyra

Table 20

Gum arabic, Talc: Exports from Sudan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	3 520	3 699	4 222	5 179	4 355	4 885	5 172	4 685	5 980	5 783	4 506
	£'000	196	142	172	311	289	292	341	371	469	463	399
of which to:–												
Belgium	M tons	3	–	1	2	1	1	2	11	1	91	16
	£'000	1	–	–	–	–	–	–	1	–	9	1
France	M tons	596	860	557	515	508	413	348	337	260	142	165
	£'000	33	33	21	28	34	27	30	26	21	12	16
German Federal Republic	M tons	22	13	37	18	44	41	44	71	78	63	25
	£'000	1	1	2	1	3	3	3	5	7	5	2
Italy	M tons	28	307	69	37	9	188	3	38	5	20	–
	£'000	1	13	3	2	–	12	–	3	–	2	–
Netherlands	M tons	622	443	145	325	334	226	212	316	300	152	–
	£'000	34	17	5	18	20	12	14	25	22	11	–
Spain	M tons	–	70	40	5	39	129	94	48	65	60	15
	£'000	–	3	2	–	3	9	6	4	5	5	1
Turkey	M tons	3	–	20	21	65	135	126	232	66	222	37
	£'000	–	–	1	1	5	10	9	19	5	19	3
United Kingdom	M tons	110	147	31	20	10	70	80	55	110	100	–
	£'000	6	5	1	1	1	4	5	4	9	8	–
India	M tons	1 935	1 581	2 799	3 906	3 147	3 297	3 913	3 192	4 222	–	3 738
	£'000	109	58	114	239	206	189	249	254	327	–	323
Japan	M tons	118	108	225	86	84	140	126	150	301	250	295
	£'000	7	6	11	5	6	10	10	12	25	20	26
Pakistan	M tons	17	–	–	5	–	45	–	–	185	4 582	–
	£'000	1	–	–	–	–	3	–	–	15	363	–
Arab Republic of Egypt	M tons	26	–	130	–	–	–	–	–	169	–	–
	£'000	2	–	5	–	–	–	–	–	12	–	–
United States	M tons	–	91	142	191	80	145	170	150	120	50	195
	£'000	–	4	6	12	6	10	12	12	10	4	20
Other Countries	M tons	40	79	26	48	34	55	54	85	98	51	20
	£'000	1	2	1	4	5	3	3	6	11	5	7

Table 21

Gum arabic, Dust: Exports from Sudan

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	143	320	217	397	590	360	777	406	375	457	518
	£'000	9	18	12	18	27	16	41	30	29	39	72
of which to:—												
France	M tons	103	318	155	267	246	286	276	161	160	155	200
	£'000	7	18	8	12	12	13	15	15	13	12	29
Italy	M tons	—	—	—	110	299	60	310	158	129	155	244
	£'000	—	—	—	5	13	3	17	10	9	13	36
Netherlands	M tons	—	—	50	—	40	10	180	87	36	122	70
	£'000	—	—	3	—	2	—	8	5	3	12	5
United Kingdom	M tons	40	2	12	20	5	—	11	—	25	—	—
	£'000	2	—	1	1	—	—	1	—	2	—	—
United States	M tons	—	—	—	—	—	—	—	—	25	25	—
	£'000	—	—	—	—	—	—	—	—	2	2	—
Other Countries	M tons	—	—	—	—	—	4	—	—	—	—	—
	£'000	—	—	—	—	—	—	—	—	—	—	2

— Nil or negligible

Source: *Foreign Trade Report*
Dept of Statistics

Table 22

Gum arabic: Exports from Nigeria

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	2 627	2 101	2 655	2 627	2 644	2 656	4 432	3 854	4 203	4 933	2 546
	£'000	296	237	290	273	294	338	580	692	782	577	419
of which to:–												
Belgium/Luxembourg	M tons	...	5	20	39	66	30	122	112	41	68	20
	£'000	...	1	2	5	8	6	23	19	7	10	4
Denmark	M tons	...	–	–	5	97	103	195	182	122	81	216
	£'000	...	–	–	1	12	13	24	29	20	15	37
France	M tons	...	111	401	165	315	678	292	1 051	1 275	806	188
	£'000	...	9	37	12	33	79	46	191	269	148	29
Finland	M tons	...	–	–	–	–	10	157	30	–	–	–
	£'000	...	–	–	–	–	1	22	6	–	–	–
German Federal Republic	M tons	...	99	396	185	554	495	621	900	839	565	858
	£'000	...	10	47	27	37	66	83	177	143	86	126
Greece	M tons	...	–	–	10	–	–	26	1	–	10	–
	£'000	...	–	–	1	–	–	3	–	–	2	–
Italy	M tons	...	–	3	13	–	6	163	159	132	7	19
	£'000	...	–	1	1	–	1	16	30	21	1	3
Netherlands	M tons	...	63	27	74	147	204	601	229	446	525	321
	£'000	...	8	3	7	18	27	89	38	94	80	53
Norway	M tons	...	–	25	20	30	15	30	20	–	–	41
	£'000	...	–	3	3	4	3	3	3	–	–	7
Spain	M tons	...	–	14	–	–	21	41	61	20	113	19
	£'000	...	–	2	–	–	4	4	10	5	18	3
Sweden	M tons	...	–	–	–	–	–	–	93	10	10	5
	£'000	...	–	–	–	–	–	–	14	2	2	1

Table 22 (Continued)

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Turkey	M tons	. . .	–	3	10	66	15	15	35	–	–	–
	£'000	. . .	–	–	1	6	1	1	5	–	–	–
United Kingdom	M tons	. . .	1 309	1 470	1 735	1 044	862	1 867	666	866	2 419	729
	£'000	. . .	150	145	151	121	103	225	106	131	164	134
India	M tons	. . .	–	–	–	32	13	2	–	–	7	–
	£'000	. . .	–	–	–	4	2	–	–	–	1	–
Hong Kong	M tons	. . .	–	10	–	10	15	20	42	105	21	42
	£'000	. . .	–	1	–	1	2	3	8	20	4	7
Japan	M tons	. . .	11	–	–	29	20	2	14	1	1	8
	£'000	. . .	1	–	–	3	3	–	4	–	–	2
Malaysia	M tons	. . .	–	35	–	5	–	2	15	2	1	–
	£'000	. . .	–	4	–	–	–	–	2	–	–	–
Singapore	M tons	. . .	–	–	15	18	–	15	42	61	20	–
	£'000	. . .	–	–	1	2	–	2	6	11	4	–
Argentine Republic	M tons	. . .	–	–	–	–	–	–	–	23	21	13
	£'000	. . .	–	–	–	–	–	–	–	3	4	2
United States	M tons	. . .	456	118	202	103	66	150	133	168	70	35
	£'000	. . .	53	30	43	31	15	21	33	41	8	4
Other Countries	M tons	. . .	47	133	154	128	103	111	69	92	188	32
	£'000	. . .	5	15	20	15	12	15	11	15	30	7

– Nil or negligible
. . . breakdown not available

Source: *Trade Report*
Federal Office of Statistics, Lagos

Table 23

Gum arabic (Dure Terlo): Exports from Senegal

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Totals	M tons	1 056	1 038	11	629	1 522	877	2 904	2 368	2 157	3 482
	£'000	112	110	1	79	195	93	410	368	388	813
of which to:–											
Belgium/Luxembourg	M tons	6	23	–	5	–	–	–	–	157	–
	£'000	1	3	–	–	–	–	–	–	30	–
Denmark	M tons	31	39	–	2	–	48	128	151	10	78
	£'000	4	5	–	–	–	7	21	28	2	19
France	M tons	809	680	–	560	1 297	496	1 417	1 054	1 057	2 244
	£'000	83	67	–	70	165	40	188	156	199	527
German Federal Republic	M tons	67	189	–	30	39	30	219	222	377	362
	£'000	8	23	–	4	5	4	36	40	70	86
Italy	M tons	27	10	–	5	14	–	443	263	112	417
	£'000	3	1	–	1	2	–	70	49	21	97
Netherlands	M tons	2	7	–	–	–	20	5	29	66	100
	£'000	–	1	–	–	–	3	1	5	11	18
Spain	M tons	18	45	10	–	10	31	74	63	–	34
	£'000	2	5	1	–	1	4	10	10	–	7
United Kingdom	M tons	5	10	–	–	–	–	332	280	175	122
	£'000	1	1	–	–	–	–	39	31	18	28
Poland	M tons	–	–	–	–	117	20	–	50	–	–
	£'000	–	–	–	–	16	3	–	5	–	–
Morocco	M tons	–	5	–	25	31	–	50	72	56	35
	£'000	–	1	–	4	4	–	9	13	11	8
Swaziland	M tons	–	–	–	–	–	–	–	–	70	10
	£'000	–	–	–	–	–	–	–	–	13	2
Brazil	M tons	–	–	–	–	–	–	–	10	–	20
	£'000	–	–	–	–	–	–	–	1	–	5
United States	M tons	55	1	–	–	7	204	215	162	64	25
	£'000	7	–	–	–	1	28	33	28	11	6
Other Countries	M tons	36	29	1	2	7	28	21	12	13	35
	£'000	3	3	–	–	1	4	3	2	2	10

– Nil or negligible

Gum arabic (Dure Kaedi): Exports from Senegal

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Totals	M tons	1 075	1 282	121	248	650	101	116	586	2 016	3 396
	£'000	117	126	15	34	75	11	14	84	398	762
of which to:–											
Belgium/Luxembourg	M tons	–	97	–	10	–	–	–	–	70	299
	£'000	–	11	–	1	–	–	–	–	14	68
Denmark	M tons	51	54	19	–	5	–	–	–	–	–
	£'000	5	6	3	–	1	–	–	–	–	–
France	M tons	949	842	50	156	545	52	116	535	1 331	1 656
	£'000	104	78	6	21	61	4	14	78	261	365
German Federal Republic	M tons	–	15	1	–	–	–	–	20	15	43
	£'000	–	2	–	–	–	–	–	2	3	11
Italy	M tons	–	28	–	5	–	–	–	–	60	40
	£'000	–	3	–	1	–	–	–	–	13	10
Netherlands	M tons	1	78	50	23	99	–	–	–	–	436
	£'000	–	9	6	3	13	–	–	–	–	107
Spain	M tons	30	5	–	10	–	–	–	10	20	20
	£'000	3	–	–	1	–	–	–	1	4	5
United Kingdom	M tons	–	56	–	–	–	–	–	10	276	633
	£'000	–	5	–	–	–	–	–	1	55	139
Poland	M tons	–	–	–	–	–	–	–	–	201	130
	£'000	–	–	–	–	–	–	–	–	37	23
Malaysia	M tons	–	–	–	–	–	–	–	–	–	35
	£'000	–	–	–	–	–	–	–	–	–	9
Morocco	M tons	12	–	–	30	–	48	–	–	–	–
	£'000	1	–	–	5	–	7	–	–	–	–
Brazil	M tons	–	–	–	–	–	–	–	–	35	40
	£'000	–	–	–	–	–	–	–	–	9	10
United States	M tons	5	50	1	–	–	–	–	–	–	10
	£'000	1	6	–	–	–	–	–	–	–	2
Other Countries	M tons	27	57	–	14	1	1	–	11	8	54
	£'000	3	6	–	2	–	–	–	2	2	13

– Nil or negligible

Source: *Commerce Exterieur de Senegal*
Ministère du Plan et du Developpement

Table 25

Gum arabic (Dure Niger-Other): Exports from Senegal

Information not shown before 1964		1964	1965	1966	1967	1968	1969	1970
Totals	M tons	102	2	51	132	971	2 794	2 362
	£'000	15	–	7	15	157	525	509
of which to:–								
Belgium/Luxembourg	M tons	–	–	–	–	39	59	6
	£'000	–	–	–	–	7	12	1
Denmark	M tons	1	–	–	–	20	10	5
	£'000	–	–	–	–	3	2	1
France	M tons	76	–	49	107	424	961	1 337
	£'000	11	–	7	13	66	180	280
German Federal Republic	M tons	–	–	–	–	–	35	193
	£'000	–	–	–	–	–	7	43
Italy	M tons	–	–	–	–	20	35	10
	£'000	–	–	–	–	4	7	2
Netherlands	M tons	–	–	–	–	424	1 270	265
	£'000	–	–	–	–	71	240	63
Spain	M tons	22	–	–	15	15	–	–
	£'000	4	–	–	1	1	–	–
United Kingdom	M tons	–	–	–	–	–	196	496
	£'000	–	–	–	–	–	35	109
Swaziland	M tons	–	–	–	–	25	223	50
	£'000	–	–	–	–	4	43	10
Other Countries	M tons	3	2	2	10	4	5	–
	£'000	–	–	–	1	1	1	–

– Nil or negligible

Source: *Commerce Exterieur du Senegal*
Ministère du Plan et du Developpement

Table 26

Gum arabic: Exports from Tanzania

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	535	762	802	466	426	629	480	188	402	512	376
	£'000	37	45	57	44	37	54	57	20	52	65	49
of which to:—												
France	M tons	—	178	242	163	159	234	211	51	125	66	89
	£'000	—	9	15	16	14	19	25	4	14	6	10
German Federal Republic	M tons	10	15	64	2	94	239	179	99	167	141	128
	£'000	1	1	4	—	9	20	22	12	24	20	18
United Kingdom	M tons	5	107	124	104	22	—	3	5	15	36	104
	£'000	—	8	10	9	2	—	—	1	2	4	14
India	M tons	511	402	217	48	60	9	10	1	—	—	10
	£'000	35	21	16	4	5	1	—	—	—	—	1
Pakistan	M tons	—	—	58	112	24	76	11	—	66	244	2
	£'000	—	—	4	11	2	8	1	—	8	33	—
Philippines	M tons	—	—	—	—	15	5	21	23	14	15	—
	£'000	—	—	—	—	1	1	3	3	2	2	—
Other Countries	M tons	9	60	97	37	52	66	45	9	15	10	43
	£'000	1	6	8	4	4	5	6	—	2	—	6

— Nil or negligible

Source: *Annual Trade Report*
East African Customs & Excise

Table 27

Gum amber and arabic: Imports into Canada

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Totals	M tons	425	522	523	581	523	498	651	627	542	506	470
	£'000	68	78	84	96	89	93	153	161	155	159	153
of which from:—												
United Kingdom	M tons	47	23	28	84	16	22	35	18	15	30	24
	£'000	5	3	4	13	3	4	7	4	4	9	6
Sudan	M tons	213	290	293	272	325	230	229	254	266	240	206
	£'000	25	32	37	37	45	31	41	50	64	62	56
United States	M tons	160	209	202	224	182	245	382	355	252	236	240
	£'000	38	43	43	46	41	58	103	106	85	88	91
Other Countries	M tons	5	—	—	1	—	1	5	—	9	—	—
	£'000	—	—	—	—	—	—	2	1	2	—	—

— Nil or negligible

Source: *Trade of Canada*
Dominion Bureau of Statistics

Table 28

Gum arabic: Imports into Brazil

		1961	1962	1963	1964	1965	1966	1967	1968	1969
Totals	M tons	448	278	510	300	423	558	420	793	436
	£'000	77.3	47.9	88.3	55.6	82.2	111.3	96.6	221.7	133.6
of which from:–										
France	M tons	137	116	144	101	40	120	109	134	80
	£'000	24.0	18.4	25.1	19.8	8.2	23.2	24.4	37.9	22.4
German Federal Republic	M tons	49	31	81	94	173	185	160	406	201
	£'000	8.6	6.0	14.5	17.5	32.8	34.7	37.1	105.9	56.2
Netherlands	M tons	20	–	–	–	43	47	12	37	5
	£'000	0.4	–	–	–	7.7	8.4	2.7	9.6	1.3
Sweden	M tons	5	–	–	–	–	–	–	–	50
	£'000	0.8	–	–	–	–	–	–	–	13.5
United Kingdom	M tons	29	16	78	28	112	89	25	100	50
	£'000	5.8	2.9	12.9	5.3	19.4	16.7	6.3	29.1	17.5
Sudan	M tons	175	95	162	34	27	42	56	58	5
	£'000	27.9	14.4	25.8	5.8	4.5	6.9	10.9	14.6	1.3
United States	M tons	32	19	20	10	26	53	33	43	42
	£'000	9.8	6.2	6.8	3.2	8.6	17.3	10.4	20.5	20.5
Other Countries	M tons	1	1	25	33	2	22	25	15	3
	£'000	–	–	3.2	4.0	1.0	4.1	4.8	4.1	0.9

– Nil or negligible

Source: *Comercio Exterior de Brazil*
Servico de Estadistica Economica e Financeira

Table 29

Gum arabic: Imports into Mexico

		1961	1962	1963	1964	1965	1966	1967	1968	1969
Totals	M tons	328	253	231	285	345	294	336	433	353
	£'000	83.2	71.9	82.1	101.3	116.1	101.9	123.8	176.4	170.1
of which from:–										
Belgium/Luxembourg	M tons	41	24	32	36	49	40	58	77	46
	£'000	6.6	4.5	6.3	7.2	9.6	7.6	11.5	16.8	10.8
France	M tons	40	27	19	18	17	10	24	19	26
	£'000	7.7	5.4	3.5	3.3	3.1	1.8	5.7	5.3	7.9
German Federal Republic	M tons	11	25	34	23	26	36	33	83	57
	£'000	2.0	4.7	7.0	5.0	5.5	7.3	8.1	23.7	17.4
Netherlands	M tons	6	12	6	12	9	4	13	11	9
	£'000	1.0	1.9	0.9	2.0	1.4	0.6	2.0	2.1	1.7
United Kingdom	M tons	91	65	27	67	76	44	70	60	69
	£'000	14.9	11.6	5.8	15.2	16.3	9.8	18.6	19.0	24.3
Sudan	M tons	–	9	7	16	6	–	6	38	5
	£'000	–	1.3	1.0	2.7	1.1	–	1.3	9.1	1.3
United States	M tons	100	62	85	100	136	140	129	136	135
	£'000	46.7	38.8	53.8	63.6	75.2	71.3	76.0	99.0	105.5
Other Countries	M tons	39	29	21	13	26	20	3	9	6
	£'000	4.3	3.7	3.8	2.3	3.9	3.5	0.6	1.4	1.2

– Nil or negligible

Source: *Comercio Exterior*
Direccion General, de Estadistica

Table 30

Gum arabic: Imports into The Argentine

		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Totals	M tons	190	113	56	190	174	306	322	334	313	385
	£'000	31.6	22.0	11.6	37.0	33.8	65.3	76.1	108.2	107.6	140.5
of which from:–											
France	M tons	–	1	15	41	18	36	58	19	35	47
	£'000	–	0.2	2.6	7.4	3.6	7.9	13.0	6.1	11.0	16.4
German Federal Republic	M tons	51	30	23	37	45	42	133	150	84	105
	£'000	8.2	4.9	4.5	7.2	8.7	9.0	31.0	45.6	26.7	38.0
Netherlands	M tons	–	1	–	20	5	–	6	24	–	–
	£'000	–	0.2	–	7	0.9	–	1.3	6.3	–	–
United Kingdom	M tons	34	11	5	42	26	94	51	71	51	71
	£'000	7.1	2.4	1.2	8.0	5.3	19.2	11.8	24.2	17.2	25.8
Nigeria	M tons	22	–	–	–	–	–	–	–	4	37
	£'000	2.7	–	–	–	–	–	–	–	0.8	6.9
Senegal	M tons	10	31	–	–	–	10	–	–	–	15
	£'000	1.6	4.4	–	–	–	1.7	–	–	–	4.3
Sudan	M tons	15	4	5	24	65	68	39	14	58	33
	£'000	2.2	0.7	0.9	4.2	11.7	12.5	8.1	4.0	15.2	10.0
United States	M tons	14	34	8	25	14	51	34	37	73	77
	£'000	4.2	9.2	2.4	6.3	3.6	14.0	10.8	17.2	33.8	39.1
Other Countries	M tons	44	1	–	1	1	5	1	19	8	–
	£'000	5.6	–	–	0.2	–	1.0	0.1	4.8	2.9	–

– Nil or negligible

Source: *Comercio Exterior*
Direccion Nacional de Estadistica y Censos

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The industrial manufacture of cassava products: an economic study

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The industrial manufacture of cassava products: an economic study

D. Edwards

May 1974

Tropical Products Institute 56/62 Gray's Inn Road, London WC1X 8LU
Foreign and Commonwealth Office (Overseas Development Administration)

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Contents

SUMMARIES Page
- Summary 1
- Sommaire 2
- Resumen 3

CHAPTER 1: INTRODUCTION 4
- Introduction 4
- Scope of the report 4
- Definition of products 5
- Structure and growth of the cassava tuber 5
- Utilization of cassava 6

CHAPTER 2: THE SUPPLY OF THE CASSAVA TUBER 7
- Introduction 7
- Supply of cassava 7
- Institutional structure of supply 9

CHAPTER 3: THE PRODUCTION OF CHIPS AND PELLETS 11
- Introduction 11
- Products 12
- Outline of process 12

CHAPTER 4: THE PRODUCTION OF STARCH 15
- Introduction 15
- Outline of process 16

CHAPTER 5: DESIGN OF THE COST MODELS 19
- Chips and Pellets 19
- Design 19
- Comments 20
- Starch 20
- Design 20
- Comments 21
- Profitability of chips, pellets and starch compared 22

Page

REFERENCES 24

TABLES 25

Table 1: Capital and annual operating costs, financial analysis: production of chips and pellets 26
Notes on Table 1 27
Table 2: Financial analysis, higher revenue assumptions: production of chips and pellets 28
Notes on Table 2 29
Table 3: Capital and annual operating costs for plantation 30
Table 4: Field equipment and personnel requirements for plantation 31
Table 5: Capital and annual operating costs, financial analysis: production of starch 32
Notes on Table 5 33
Table 6: Capital requirements: production of chips and pellets 34
Notes on Table 6 35
Table 7: Capital requirements: production of starch 36
Notes on Table 7 37
Table 8: Raw material and other inputs: production of chips and pellets 38
Table 9: Raw material and other inputs: production of starch 39
Table 10: Personnel: production of chips and pellets 40
Table 11: Personnel: production of starch 40

APPENDIX 1: Commercial requirements and official standards for cassava products (with references): by Jean S. Ingram 41

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We would point out that mention of a company and/or product, and its use in the cost models, does not imply a recommendation of the company (or product) to the exclusion of others which may also be available.

Summaries

SUMMARY

This report is one of a series of economic studies designed to facilitate investment decisions within developing countries. The basis of the report is a set of financial and physical cost models in which processing methods and modes of operation are compared. Although the financial analysis is based on factor costs in a South East Asian country, the physical requirements are so presented that by appropriate adjustments for local yields and other factors, the factor costs can be readily applied to other areas. A description of the manufacturing processes is given.

As well as details of manufacturing requirements, the supply of cassava tubers is considered. The interaction of supply to an industrial enterprise with subsistence farming and other food uses necessitates careful planning of supplies if the enterprise is to operate successfully. Accordingly a simple costing of a plantation has been developed from which part of a factory's supply of cassava tubers can be drawn. This has been used as the basis of supply for one of the cost models.

The cost models can be divided into two sections: firstly, four for the production of chips and pellets and, secondly, four for the production of starch.

Model A: 700 tonnes of dried chips per shift per year.
Model B: 4,900 tonnes of dried chips per shift per year.
Model C: 4,900 tonnes of pellets per shift per year.
Model D: 9,800 tonnes of pellets per shift per year.

From the above models it is possible to compare the scales of output and to consider the relative profitability of extending production from dried chips to pellets. Model D takes account of the possibility of an enterprise purchasing dried chips for pelleting instead of performing both processes.

Model E: 1,075 tonnes of starch per shift per year.
Model F: 3,225 tonnes of starch per shift per year.
Model G: 3,225 tonnes of starch per shift per year.
Model H: 535 tonnes of starch per shift per year.

The first three models use a similar, modern process but on a different scale. The difference between Model F and Model G is that the latter draws 50% of its cassava tubers from the plantation. Model H represents an attempt to cost a factory at a smaller scale using traditional processing equipment.

An analysis of these models is given and the working assumptions and results discussed. A comparison is made between the relative profitability of the models. Commercial requirements and official standards for cassava products are outlined in an appendix.

SOMMAIRE

La fabrication industrielle de produits de manioc: une étude économique

Ce rapport fait partie d'une série d'études économiques ayant pour but de faciliter les décisions concernant les placements dans les pays en cours de développement. Le rapport se base sur une série de modèles des coûts physiques et financiers dans lesquels on compare les méthodes de transformation et les modes d'opération. Bien que l'analyse financière soit basée sur les coûts facteurs pour un pays de l'Asie du Sud Est, les demandes physiques sont présentées de telle façon que, par des ajustements appropriées des rendements locaux et autres facteurs, les coûts facteurs peuvent très bien s'appliquer à d'autres régions. Le rapport fournit une description du procédé de fabrication.

On considère l'approvisionnement en racines de manioc de même que les détails des nécessités de la fabrication. L'action mutuelle de l'approvisionnement d'une entreprise industrielle avec l'agriculture de subsistance et les autres domaines alimentaires fait appel à une organisation méticuleuse de l'approvisionnement afin de permettre à l'entreprise de bien fonctionner. Ainsi, on a développé une évaluation simple pour une plantation pouvant fournir une partie de l'alimentation de racines de manioc d'une usine. On se sert de ceci comme base d'alimentation dans un des modèles de coût.

Les modèles de coût peuvent être répartis en deux sections: premièrement, quatre pour la production de copeaux et de grains et deuxièmement, quatre pour la production d'amidons.

Modèle A: 700 tonnes de copeaux secs par équipe par an
Modèle B: 4 900 tonnes de copeaux secs par équipe par an
Modèle C: 4 900 tonnes de grains par équipe par an
Modèle D: 9 800 tonnes de grains par équipe par an.

A partir des modèles ci-dessus, il est possible de comparer les ordres de débit et de considérer la rentabilité relative d'une expansion de production, des copeaux secs aux grains. Le modèle D tient compte de la possibilité d'une entreprise achetant les copeaux secs pour les transformer en grains au lieu d'entreprendre les deux procédés.

Modèle E: 1 075 tonnes d'amidon par équipe par an
Modèle F: 3 225 tonnes d'amidon par équipe par an
Modèle G: 3 225 tonnes d'amidon par équipe par an
Modèle H: 535 tonnes d'amidon par équipe par an'

Les trois premiers modèles utilisent des procédés modernes semblables mais sur des échelles différentes. La différence entre les modèles F et G est que G prend 50% de ses racines de manioc dans la plantation. Le modèle H représente un essai d'établir le coût d'une usine de plus petite envergure utilisant d'appareillage de transformation traditionnel.

Le rapport fournit une analyse de ces modèles et débat les résultats et les hypothèses d'opération. Il compare aussi les rentabilitées relatives des modèles. Les nécessités commerciales et les standards officiels des produits à base de manioc sont ébauchés dans un appendice.

RESUMEN

La elaboración industrial de productos de mandioca: estudio económico

Este informe forma parte de una serie de estudios económicos cuyo objetivo es facilitar decisiones en materia de inversiones en países en vías de desarrollo. Tiene como base un conjunto de modelos de costes financieros y físicos en los que se comparan métodos de elaboración y técnicas operativas. Aunque el análisis financiero basa el factor coste según un país del Sudeste asiático, los elementos físicos se presentan de tal forma que, por medio de ajustes apropiados para rendimientos locales y otros factores, dicho factor coste puede aplicarse a otras zonas. Este informe ofrece también detalles de procesos de elaboración.

Además de las necesidades de fabricación, se ha estudiado el suministro de tubérculo de mandioca. La influencia mutua de empresas industriales con el cultivo y otros usos alimenticios, requiere una planificación cuidadosa del abastecimiento si se desea que la empresa tenga éxito. De esta forma, se ha formulado un coste simple de plantación que puede suministrar parte de las necesidades de tubérculo de mandioca a una fábrica. Este ha sido considerado como el suministro base para uno de los modelos de coste.

Los modelos de coste se pueden dividir en dos secciones: primeramente, cuatro para la producción de virutas y trozos, y segundo, cuatro para la producción de almidón.

Modelo A: 700 Ton. por tanda de viruta seca anual.
Modelo B: 4 900 Ton. por tanda de viruta seca anual.
Modelo C: 4 900 Ton. por tanda de trozos anual.
Modelo D: 9 800 Ton. por tanda de trozos anual.

Se pueden comparar las escalas de producción de acuerdo con los modelos anteriores y considerar el rendimiento relativo ampliando la producción de viruta seca a trozos. En el modelo D se considera la posibilidad de la adquisición por una empresa de viruta seca para la elaboración de trozos, en lugar de realizar ambos procesos.

Modelo E: 1 075 Ton. por tanda de almidón anual.
Modelo F: 3 225 Ton. por tanda de almidón anual.
Modelo G: 3 225 Ton. por tanda de almidón anual.
Modelo H: 535 Ton. por tanda de almidón anual.

Los tres primeros modelos utilizan un proceso moderno similar, aunque a una escala distinta. La diferencia entre el Modelo F y G consiste en que en el último se obtiene el 50% del tubérculo de mandioca de la plantación. El modelo H representa un ensayo de coste de fábrica a una escala menor, empleando maquinaria de elaboración tradicional.

Se facilita un análisis de estos modelos y se analizan supuestos de trabajo y resultados. Se hace una comparación de las rentabilidades relativas de los distintos modelos. Las necesidades comerciales y standards oficiales de productos de mandioca se detallan en un apéndice.

Chapter 1

Introduction

This report is one of a series of economic studies designed to facilitate investment decisions within developing countries. It is related to other reports on cassava prepared, or being prepared by the Tropical Products Institute.[1, 2, 3]

In the preparation of the report, the intention has been to meet two needs.

a. An increased interest in the processing of cassava throughout the tropical world, evidenced by the growing number of inquiries on the subject received by the Tropical Products Institute.

b. The more general concern with the problems of rural development and the attempt to promote diversification of economic activity within rural areas.

The report is designed as a guide to investment setting out the conditions and factors necessary in the establishment of a processing enterprise. As such it is concerned basically with economic rather than technical aspects. The main emphasis in the report is on a series of physical and financial cost models in which various processing methods and modes of operation are compared. To a very great extent these models are based on operational data collected in factories processing cassava in developing countries and producing commercially acceptable products. The brief descriptions of the processes in Chapters 3 and 4 are not intended to cover all alternative methods of processing chips, pellets or starch, but only those to which the models relate. The processes in question are, however, capable of being applied in other countries.

The machinery costs were supplied by a European firm in 1972. The prices of cassava tubers, chips, pellets and starch were collected in a tropical Asian country in 1971 and in order to preserve an actual relationship have not been amended. Other factor costs collected in that country have been raised somewhat to allow for inflation.

The supply of the raw material has been given careful attention as this is an important factor in the successful establishment of a cassava processing enterprise.

It must be emphasised that the report is not intended to serve as a production handbook, but as an aid to economic decision making. Normally, the successful launching of a new undertaking requires expert technical supervision on the spot, which may have to be maintained over a long period.

SCOPE OF THE REPORT

The report is confined to an assessment of two types of product derived from the cassava tuber:

a. the production of chips and pellets for animal feed;

b. the extraction of starch.

Both these products can be produced in any area where cassava is grown, and are widely marketed internationally as well as domestically in the country of production.

It was decided to exclude the production of processed foodstuffs based on cassava, such as gari in West Africa or farinha in Latin America, since the production of these depends on local tastes and markets.

DEFINITION OF PRODUCTS

The cassava plant is known botanically as *Manihot esculenta* (Crantz). It is distributed over a large area of the tropical world and is known under a variety of names: cassava in English speaking Africa; manioc in francophone Africa; manioc, mandioca, yuca, in Latin America; tapioca in tropical Asia.

The descriptive terms applied to cassava and its products have been noted for their interchangeability. In order to avoid confusion it is necessary to define the terms as understood by this report. Within European trade, use of the term 'manioc' or 'cassava' refers to the dried or sun-dried tubers (chips, meal, flour); 'tapioca' or 'tapioca starch' is confined to the products derived by the wet-processing of the tubers, but not including grocery tapioca. This is the meaning followed in the report. The manner in which the terms flour and starch have been applied has also given rise to confusion. Flour will be understood as the finely-ground dried tubers from which starch has not been extracted. Starch will be understood as the fine powdery material obtained by wet-extraction from the pulped roots.

STRUCTURE AND GROWTH OF THE CASSAVA TUBER[4]

Cassava is produced under a variety of conditions and systems of farming; the established practices of cultivation and yields of tuber vary accordingly. The plant is propagated by means of stem cuttings and develops an extensive fibrous root system, both laterally and vertically. It normally reaches a height of 1–3m producing a leaf cover. The tubers develop by a process of secondary thickening of the roots, forming a cluster at the base of the stem. In size they vary from 30 to 150 cm long and 4 to 15 cm in diameter; the weight ranges from 1 to 8 kg. The size of the tubers is determined by the variety of plant in conjunction with the soil and climatic conditions.

The mature tuber consists of three parts. The peel has an outer layer of cork cells and the phellogen and an inner layer which contains the phelloderm and the phloem. The third part is the core, which is the main storage region of starch. The peel has only half the starch content of the core, and as it is harder it is more difficult to rasp. It is, therefore, completely removed in small processing enterprises, although the larger ones confine removal to the outer cork layer. The cork layer represents 0.5–2 % of the total tuber weight, and the inner peel from 8–15 %. The tuber varies in composition according to the variety of plant, soil and climatic conditions and the age of the plant. The following percentages indicate the composition of the tuber; they should not be regarded as constants and values outside this range occur:

Water	–	65–70 %
Starch	–	20–30 %
Sugars and fats	–	5 %
Protein	–	1–2 %
Fibre	–	1–2 %
Ash	–	0.5–1 %

An enterprise processing starch is interested in the yield of starch per hectare, which depends on two variables: firstly, the yield of tubers per hectare, and, secondly, the yield of starch per tonne of tubers. The starch content of the tubers varies over the growing period as well as with variety, and the time of harvesting is, therefore, important. After planting the root system grows rapidly, but immature tubers have a low starch content. Within a few months the growth slows down and the starch content increases rapidly. The tubers reach a maximum size with a starch content of 25–30 % or occasionally higher. This may be considered a stage of maturity during which the tubers are ideal for processing. The time taken to reach maturity will vary widely, depending on variety of plant and environmental conditions; perhaps 12–18 months may be taken as typical. If the tubers are left in the ground beyond this stage, the starch content may continue to increase. It may reach a level of 30–35 % of total tuber weight, but lignification takes place. The tubers then become tougher and woody, making preparation and processing more difficult. The yield of *extractable* starch declines rapidly.

The tubers should be processed within 48 hours of harvesting; beyond that time there will be a deterioration in quality. Initially this is due to enzymatic changes taking place, while the tuber will be increasingly vulnerable to rot and decay.

A classification of cassava into 'sweet' and 'bitter' varieties has often been made. This division has been related to the toxicity present in cassava, but it should be regarded as an approximation which requires further investigation. The toxicity in cassava appears to arise from the presence of the cyanogenic glycoside linamarin. When hydrolysed under the influence of endogenous enzyme linase, hydrocyanic acid is liberated. Generally the 'sweet' varieties have been considered to exhibit lower degrees of toxicity. However, no exact correlation has been established and a considerable overlap by degree of toxicity can be observed between varieties. Experimental work on the nature of the toxicity is still required. As well as variety, ecological conditions also have an effect on the hydrocyanic acid content. The cyanogenic glycosides are distributed throughout the plant: the concentration varies with variety, climate and edaphic conditions. However, the concentration is usually considerably higher in the peel of the tuber then in the flesh.[5]

UTILISATION OF CASSAVA

The major use of the cassava tuber is as the staple source of carbohydrate in the diet in many tropical countries, although nutritionally it is not a balanced food. The 'sweet' tuber is sometimes eaten after peeling, boiling and simple preparation; alternatively it is processed into a range of products for marketing in urban as well as in rural areas. These products include the foodstuffs obtained by fermentation and heating such as gari in West Africa. In terms of food use the most recent development has been the experimental work in progress on composite flours, using cassava starch as a partial substitute for wheat flour.

Cassava has a number of other uses: in the animal feed industry (see Chapter 3), and as a source of starch and products derived from those starches (see Chapter 4). Baked tapioca products or grocery tapioca are derived from cassava starch by means of a heat treatment of moist starch in shallow pans; wet granules gelatinize when heated, burst and stick together. The products are known as flakes (irregular lumps), pearls and seeds (small round beads). These products are marketed in Europe.

Chapter 2

Supply of the Cassava Tuber

INTRODUCTION

The economics of processing cassava are affected by two competitive situations. The technical efficiency of the process in operation does not alone determine profitability. In a technical sense a plant may be running efficiently, but financial loss may still be incurred. The competitive situations referred to are:

a. The supply of cassava
   (i) the processing enterprise may be competing with alternative uses of the cassava tuber, especially its use as a food crop in subsistence agriculture
   (ii) the production of cassava competes with alternative crop patterns on the land

b. the demand for the processed product; the market for which is competitive in that substitute products are available.

This chapter will be concerned with assessing the effect of the supply of the tuber on the economics of processing. General features of the market will be mentioned in Chapters 3 and 4. A comprehensive study of markets for cassava and cassava products has been completed recently.[6]

SUPPLY OF CASSAVA

In assessing the effect of the supply of cassava two issues have to be considered, although these are not independent. Firstly, the price that has to be paid to obtain the tuber, and, secondly, the continuity of supply. In order to examine these it is necessary to consider the function of cassava when grown by the farmer, and the manner in which this affects supplies to the processing enterprise.

Cassava is a food crop widely used as a basic item in the staple diet of most of the producing countries. Where it is grown by a partially subsistence agriculture, much of the output is consumed directly by the producer and his family. Although cereal products such as maize or millet may be a preferred foodstuff, cassava is valued because it is less subject to yearly fluctuations in output, and because of its resistance to drought and its ability to be grown on relatively poor soils. It is partly grown as a reserve crop for periods of famine, a function facilitated by its ability to be left in the ground until needed. The cassava supplied to a processing enterprise may, then, be by nature residual to family consumption needs. In these circumstances the supply will fluctuate and will not be particularly responsive to price changes, ie it will be price inelastic. Two functions of cassava have been identified here:

(i) as a crop which can produce more calories of food per unit of labour than most other tropical crops

(ii) as a safeguard against the risk of failure in other food crops.

Both these factors make it highly attractive to the subsistence farmer. Beside traditional food uses, however, cassava is also sold in rural and urban markets as both a fresh and a processed foodstuff. In so far as there is such a market for the cassava tuber, supply becomes a further complicated issue.

The price that a processing enterprise can offer the farmer for cassava tubers is constrained by the price which it can consistently obtain for its output, given its processing costs and a profitability objective. The producer of a cassava-based foodstuff such as gari operates within a localised market. In conditions of food shortage, perhaps due to a poor cereals' harvest, the price of the output, gari, rises. The producer of gari is then operating within a less rigid financial constraint and is able to offer a higher price for the tuber. Farmers will then tend to divert sales of tubers to producers of gari. In order to compete for the supply of tubers, the enterprise processing chips, pellets or starch would have to respond accordingly. However, it is not operating within the same localised conditions, but in a global market where price of the finished product is likely to exhibit a greater degree of stability. In this situation there are two possibilities which can adversely affect the profitability of the enterprise. Firstly, raising the price paid for tubers will directly raise unit costs of production. Secondly, the failure to respond to the higher price paid for tubers by the food-processors may result in a short-fall of supplies; running for a period at substantially less than capacity will increase unit costs of production as depreciation and other fixed costs have to be set against a lower output than planned for.

The problem arises from two circumstances. Firstly, the farmer will naturally sell tubers at the highest obtainable price. However, given the functions of the tuber identified above and the fluctuation in prices offered by the food-processors, an increase in price will not necessarily induce a long-term increase in the planting of cassava for cash sales. Secondly, the structure and the conditions prevalent in the markets for the products of the various forms of processing are different. In so far as the domestic animal feed market is subject to the same pressures of supply as the human food industry in the event of a local cereals' crop shortfall or failure, a higher price may be obtainable for cassava chips and pellets as a partial substitute. For the manufacturer of chips and pellets making sales on the domestic market the financial constraint will be eased somewhat, enabling a higher price to be paid for tubers.

Export of cassava products is easier for those countries in which the supply of food and land does not necessitate the widespread consumption of cassava as a foodstuff. In a few areas of the world cassava is grown primarily to provide the farmer with a cash income and does not feature to a great extent in the local diet. The world's principal exporter of cassava products is Thailand, although the total production of the crop is low in comparison with countries such as Brazil and Indonesia. The reason for Thailand's ascendancy as an exporter is that cassava is not part of the staple diet, but was introduced as a cash crop to be exported in the processed form of chips, pellets or starch.[7, 8]

The supply schedule of the crop will be dependent on the alternative uses of resources possible. The price offered for tubers will have consistently to present the farmer with an income at least equal to that from other products. The yield of the crop and the risk attached to that yield will determine the expected revenue at a given price for tubers; the net income will be dependent on the costs of production. Cassava has the advantages of low risk, relatively high physical yield, low labour input, and can be grown on relatively poor soils. Against these have to be set its low value and the length of the growing season; for other products more than one crop may be obtainable in the same period.

The above has established a problem of supply due to the structure of production and the alternative opportunities available to the farmer. A further issue to be considered, particularly for the enterprise engaged in the production of starch, is control of harvesting. Such an enterprise requires some control over the production of tubers as there is an optimum time for harvesting, given that the starch content of the tuber is not a constant (see p.6). For the starch enterprise, the most profitable time for harvesting is the point or period at which *extractable* starch content is at a maximum. In order that farmers harvest at the correct time, a system of differential pricing has sometimes been advocated and adopted. A basic rate is paid for tubers with a scale of premium payments in proportion to the starch content of the tubers above a certain level. To adopt such a system requires an agreed method of sampling and assessing the average starch content (see p.16).

The interest of the processing enterprise is not confined to the time of harvesting. Different varieties of the plant contain different amounts of extractable starch and the processing enterprise therefore has an interest in determining the variety grown by its suppliers. In particular, 'bitter' varieties are widely considered to give a higher yield of starch than 'sweet' varieties. An industrial operation is unlikely to be successful unless it is based on high starch-content varieties of cassava.

INSTITUTIONAL STRUCTURE OF SUPPLY

The problems of supply of the tubers have been emphasised because, as will be seen in Chapter 5, the supply and cost of tubers is a crucial determinant of the profitability of processing. In the previous section the nature of the problem has been established; in the present section the manner in which the problem could be dealt with is considered.

Two possibilities have been widely canvassed as a solution. Firstly, the creation of a co-operative organisation among the smallholders with assistance given through the capacity of advisory services and credit facilities.

Some degree of control would be required over production planning and harvesting; tubers to be supplied on a regular basis at an agreed price for specified quality. In some areas, for small-scale operations, encouragement might be given to extending the co-operative activity into processing itself. Secondly, for large enterprises the establishment of a plantation on which to grow all or part of the tuber needs.

Attention will be concentrated here on the latter, as the report is concerned with the investment and operational requirements of an enterprise. The agronomic details will not be considered in depth, but will serve to illustrate the cost assumptions. The establishment of a plantation will be applied to only one of the cost models in Chapter 5 for comparative purposes.

For the establishment of a plantation the following details should be investigated:

a. The types of soil, topography, annual rainfall and climate in the area or areas chosen for consideration as potential sites.

b. The variety of cassava to be grown taking account of the details at a.

c. The yield per hectare expected in minimum and average growing conditions and the time taken for the plant to reach maturity.

d. Having established the proportion of the factory's tuber needs to be met by the plantation, the area needed to grow that amount.

e. The modification of the estimated area to take account of a rotation allowing the soil a period of fallow.

f. Whether those sections under fallow would be put to use, eg in the cultivation of grass leys as cattle feed.

g. The time taken for the plantation to reach full-production potential, dependent on the phasing of the clearing and planting operations.

h. The development costs of clearing and preparing the land. The recurrent costs of planting, weeding, harvesting and transport of the crop. Equipment and labour needs for these activities.

i. The arrangement of a scheme for the accumulation of planting material.

To provide an illustration we have prepared a costing for a typical plantation in the country whose factor costs have been used in this report. In any given situation the costing should be modified in the light of a survey relating to the nine aspects mentioned in the foregoing paragraph. However, the figures used below are probably close to average.

The plantation costing is related to a factory requiring an input of 6 tonnes of tubers per hour, 3 shift production a day, 290 days a year, making a total tuber input of 42 000 tonnes a year. It is assumed that the plantation will provide 50 % of this requirement, that is 21 000 tonnes or 1 750 tonnes a month.

The yield assumed is 30 tonnes per hectare which is considered attainable in the particular country. The growing period is stated as 12–15 months; the former figure is taken in the costing. Although not stated, a fallow period might be assumed. A rotation in 5 years of 3 crops of cassava and 2 years in grass leys or other suitable crop could be taken. A costing has not been applied to the fallow, but it is assumed that the operation breaks even.

An input of 1 750 tonnes at a yield of 30 tonnes per hectare requires that 58 hectares a month of mature tubers be available. Clearing this area a month and then preparing would make available a steady flow of tubers at this rate 12 months on. In addition to allow for the fallow period a further 468 hectares would have to be cleared, making a total of 1 164 hectares. The contract price for the clearing would be £100 per hectare. In addition another 116 hectares might be assumed for road construction, buildings etc. The total investment in development cost of the land would be:

1 280 hectares @ £100 per hectare = £128 000.

The costing assumes that ploughing, ridging, planting and field upkeep are undertaken by machinery; fertiliser may also be applied by the planting equipment. The cost of the fertiliser applied was derived from factory data.

However, no details other than total cost were given. The type and amount of fertiliser to be applied will vary with soil composition and in each case local conditions should be studied carefully. The weeding is partly undertaken by hand labour. Harvesting is undertaken by contract labour. The average distance travelled to the factory is assumed as 50 km a round trip; the tubers are carried by 10 ton lorries making two trips a day, requiring four lorries in all. The field equipment is related to the acreage under cassava.

The cost details are set out in Tables 3 and 4, pp 30, 31. The cost per tonne of tubers delivered at the factory is given as £3.44 at row 19, Table 3; this cost includes no allowance for a return of the capital invested in the plantation. Taking a notional return (before tax) of 12 % per annum would increase the cost of tubers to £4.44 per tonne.

Chapter 3

Production of chips and pellets

INTRODUCTION

The production of chips and pellets is geared to the requirements of the animal feed industry, although edible chips for human food consumption are produced in some areas. The products are sold on domestic and international markets. In recent years the international market has been characterised by a trend in favour of dried cassava products (chips and pellets) instead of cassava meal. Cassava meal is the powdered residue of chips and tubers after processing to extract the edible starch; the starch content is lower than in the other products and cassava meal is produced by some starch extraction enterprises as a by-product. As it is considered an inferior product, its international use has been declining; domestically, markets are likely to continue with direct sales to farmers.

The recent impetus to the installation of pelleting machinery has come from the demand generated within the European Economic Community for cassava products as a source of energy in animal-feed. For this purpose cassava is used as a fattening agent and competes with grain products such as maize and barley. Its use in animal-feed formulations is dependent upon the balance between relative price levels and feed values. There is also an upper limit to the proportion of cassava acceptable in animal-feed formulations. The growth in demand from the EEC has been stimulated by the structure of the Common Agricultural Policy which set high domestic grain prices and a low tariff on imports of cassava products to the animal-feed industry.[9]

The compound animal-feed industry in most developing countries is not as sophisticated nor as well organised as those of Europe and North America, partly as a result of the type and organisation of farming. However, the desire to increase the output of food products from animals is leading to efforts to reorganise and improve animal husbandry. In the future the requirement for a more efficient and larger compound animal-feed industry is likely to be generated by this activity.

Internationally, there has been a change in the relative positions of chips and pellets in favour of an increased consumption of the latter. Pellets have a number of advantages over chips, and are, in particular, a more convenient form for export having a higher bulk density. Cost advantages following from this are a reduction in handling and storage costs, fewer bags per tonne of product, and lower sea-freight charges, which are based on volume and not weight. It is possible to obtain a more uniform quality of product, while pellets are more likely to reach their destination sound and undamaged. However, in Euopean markets there is a preference for bulked cargo in order to facilitate handling and storage; the saving on bags is then of less relevance. Due to the quality factors and other savings, pellets receive a premium price over that of chips. Within the domestic market, the advantages of pellets are less marked.[9]

PRODUCTS[4]

Chips are the dried sliced or chipped pieces of tuber; the length of these is usually up to about 6 cm. Broken roots, being larger pieces, are also produced. Pellets are the product of the grinding and hardening of dried chips and broken roots into a cylindrical shape. These vary in size; about 2 cm long and up to 1 cm in diameter (in Thailand 0.4 cm and 0.8 cm).

The production of chips and pellets can be divided into a number of operations, thus:

chips — washing, peeling, chipping, drying, bagging;

pellets — washing, (peeling), chipping, drying, pelleting, bagging.

The extent to which peeling is undertaken varies; in the case of pellets it is often considered to be unnecessary. Broken tubers may also be included in the material input to the pelleting presses. Bagging is omitted where bulk cargoes are preferred. It is possible that products might be transported to ports in bags for emptying into bulk ships, if an adequate system for bulk handling throughout is not available.

The operations can be performed by a variety of methods; those adopted depend on the institutional structure and scale of production. Traditionally, the operations of washing, peeling and chipping have been performed by hand. Specialisation of activity within the village increased the scale of operation and gave scope to the introduction of simple mechanisation. In particular, for chipping a simple chipping machine rotated by treadle or handle would replace slicing by hand at a slicing table. The introduction of diesel and electric motors facilitated a further increase in the scale of operation. This has applied to washing and peeling as well as to chipping. However, the equipment used in these operations is usually still of local design and construction, being relatively simple structures readily made of locally available material. The introduction of pelleting presses has been the latest activity in the industry, representing an adjustment to changing international market opportunities. A high level of quality is required in international markets, and the standards required by various countries are outlined in Appendix 1.

OUTLINE OF PROCESS

On arrival at the factory site the tubers, after weighing, are unloaded from the lorry. The system of storage is usually one of bunkers made of material such as concrete, divided into sections. The production plan should ensure that the tubers are used in the order by which they arrive. The stock of tubers would not exceed one to one and a half day's production needs.

From storage the tubers are taken by band conveyor and lifter to a hopper, from which they fall into a washer-peeler. This machine is divided into sections; in the first section the tubers are cleaned of adherent dirt and sand, in the second they are peeled (only the outer cork layer). A variety of machines are used. One example consists of a tank with a concrete base and a wooden casing. Along the length of this runs a rotating hollow metal shaft (perhaps of 15 cm diameter). Iron spikes or wooden paddles project from either side of the shaft with succeeding pairs set at right angles to each other; these facilitate the turning of the tubers. Jets along the shaft spray water countercurrent to the flow of tubers; the water is pumped along the shaft by a centrifugal pump. In the peeling section, the tubers continue under the water spray and are peeled by friction and the action of rotating iron spikes. At the end a lifting device carries the tubers onto a band conveyor. The dirty water and skin are drained periodically from the base of the machine.

From the washer-peeler the cleaned tubers are taken by band conveyor and lifter to a large hopper from where the tubers fall by gravity into a chipping machine. The capacity of the hopper is dependent on the throughput of tubers per hour.

Chipping machines are invariably of local construction. An engineer at the Tropical Products Institute has given the following details of a machine for chipping; based on an example seen in use in South-East Asia.

The machine consists of a rotating disc 1 m in diameter with the cutting face at right angles to the horizontal plane. The six serrated cutting blades are positioned radially and pitched equally around the disc. Provision is made for adjustment of these blades and for their replacement. The complete cutting assembly is mounted on a central boss with radial stiffening members. The drive shaft is connected to this boss and is carried in two plummer block-type bearings arranged with the cutting disc outboard and drive pulley carried between these bearings.

A heavy timber frame constructed at right angles is arranged to carry the complete cutting and driving assembly. This frame incorporates a feed hopper which encloses the upper semi-circle of the cutting disc. The circumference of the cutting disc is mounted within the timber frame with suitable working clearance. Power is provided by a diesel engine or electric motor with clutch via a 2:1 ratio belt drive, the engine is mounted on a rigid base and the drive enclosed within a timber guard. The chips produced are 6 cm long x 0.5 cm wide. It is emphasised that consideration should be given to the safety aspects of the machine. The machine is capable of producing 0.6–1 tonne of wet chips per hour. Twenty man-days would be required for production and assembly. Material costs would be of the order of £425.

The wet chips are collected and taken to the area for drying. Since cassava chips are a comparatively bulky, low-value product and the water content of the material is high (see p.4), the main requirement is for as low a fuel cost as possible, subject to the satisfaction of other cost and quality conditions. Hence the simplest and most widespread form is that of sun-drying, which in terms of fuel (solar heat) is costless as compared with the fuel requirements of artificial methods of drying.

Sun-drying involves an investment in land, concrete work, and time. The usual method is for wet chips to be spread onto an open concrete drying ground, the extensive area which this requires being a disadvantage of the method. The time taken to dry the chips to a moisture content of 12–13 % varies substantially with weather conditions and how well the chips are spread during drying. In ideal, continuously sunny conditions, drying can be completed in 2–3 days, but in general 3–10 days (or more) must be expected.[3, 4] The chips should be turned periodically to ensure even drying. As well as an extensive concreted area, investment is required in a simple protective structure into which the drying chips can be pushed when rain threatens, and where the chips can be stored at night. In some cases a tractor with boards fitted at the front is used to push the chips under cover. It is advisable that the drying grounds should slope slightly to facilitate the draining of rain water, with the protective structure sited at the higher end. The chips can be spread by hand; labour is needed for the turning of chips.

Sun-drying will cause some wastage and deterioration in quality, although an estimate of its extent can only be gained by operational experience. Where the chips are being pushed into and out of sheds, some will, in being bruised and broken, become susceptible to attack by bacteria and mould. The longer the time taken in drying, the more likely it is that the chips will be subject to such damage. Semi-dried chips that become wet again during drying will, on completion of drying, lose something of their firmness in texture; it is also important that chips have the required moisture content throughout and are not too moist on the inside although dry on the surface.[3] To some extent this will depend on the judgement of the operatives controlling the drying.

If economically feasible, a technically efficient artificial drier would have certain advantages. It would enable a more uniform quality and quantity of product. Production would not be dependent on the weather and could be continued into a monsoon season in those areas where this is experienced. Indeed the main advantage of artificial drying would be for those areas where sun-drying is inhibited or not practical because of climatic conditions. In reducing the drying time substantially, an artificial drier would reduce that part of the working capital represented by work in progress, i.e. the number of day's production being dried at any one time. The problem is the prohibitive fuel cost; an artificial drier might be more feasible if combined in some manner with solar heat.

On completion of drying, chips to be marketed as such are collected for bagging and storage. Jute or other woven sacks are considered suitable for packing. Insect infestation and the development of moulds are a problem in the storage of dried chips. Good storage hygiene in the empty premises, and later fabric spraying with lindane at regular intervals would assist in the control of the dried chips received for storage.[3] Up to one month's production might be held in store, depending on the regularity of shipment.

In the case of those chips to be processed into pellets, the dried chips would be stored more conveniently in bulk, at the rate of 1–2 days' production of chips. These are available for feeding into the pelleting presses the next day. Dried chips to be fed into the pelleting presses should have a maximum moisture content of 14 %.

A pelleting plant consists of one or a linked series of small pelleting units. The capacity of the plant is dependent on the number of such units in operation and the capacity of each individual unit. The capacity of the pelleting units or presses is a function of a number of variables: the pellet diameter, the composition, fineness and bulk density of the product to be pelleted, the addition of moisture (steam or water), the steam pressure, and the hardness of pellets. The dried chips are taken from storage by hand or by conveyor and lifter to an intake hopper. From the hopper the chips move by conveyor under an overhead magnetic separator for removing iron particles, and then to a vibration screen where sand and dirt are sieved out. The chips are then passed through a crusher to produce a finely ground material and carried into a storage bin. The ground material is carried along a trough conveyor to a series of hoppers. Each hopper feeds a pelleting press via a feed worm with facilities for steam inlet. In the press, rollers or grinders push the ground material through the perforations of a horizontal die, the material being cut as pellets as it emerges from the other side. The perforation size determines the diameter of the pellets, and the depth of the die determines the length of pellets. The rollers and dies have to be replaced at intervals. From the pelleting press the pellets move by belt conveyor into a belt cooling system, which is stationary while cooling takes place. From the cooler the pellets pass through a weigher-sacker where they are bagged, and thence into storage.

Pelleting may be a specialised activity in itself. This is the case in Thailand, at present the major world source of cassava pellets.[10] The structure of the industry is such that three tiers can be observed. The cassava is moved from the farmer to be chipped and dried by small firms, and thence the dried chips are supplied to large, specialised pelleting firms, which are heavily capitalised. Two types of pellets are recognised. 'Branded' pellets are produced on superior equipment from better quality chips. 'Native' pellets are considered an inferior product, being produced on presses using cheaper, locally made dies and rollers and not always undertaking the sieving of sand.

In the establishment of the pelleting industry a number of problems have arisen. Driers have been known to adulterate the product to increase revenue by increasing the sale weight; as well as causing a reduction in quality, this action also increases wear and tear to the presses from foreign matter. Driers do not always keep to the required drying time, and the moisture content of dried chips may rise above desired levels. It is recommended that the moisture content should be kept below 14 %. A higher moisture content would permit the development of bacteria and mould in the pellets.

Chapter 4

Production of starch

INTRODUCTION[4]

The starch extracted from the cassava tuber has a variety of uses, many of which it has in common with starches derived from products such as potatoes, maize and wheat. The basic division of starches is into food and industrial grades. The former are used by the food processing industries; the latter in a wide range of industries, in particular the textile industry. For some processes, particular characteristics of tapioca starch create a market preference (for instance, in the finishing stage of textile production). Other than this, it is competing in terms of price and quality with the other starches, and for a few processes with synthetic products (such as polymers in the textile industry).

The largest consumer of starch is the starch conversion industry which produces glucose syrup and the dried product, dextrose. These compete with sucrose derived from cane and beet sugar, for which they are a partial or complete substitute. These materials are used in industries such as fruit canning, confectionery, bakery, ice-cream manufacture, beverages and alcoholic fermentation, etc.

Other uses of starch in the food industry generally are as a thickener or filler in such products as custard, soup, baby food, ice-cream and pharmaceuticals, as a binder in sausages and processed meats and as a stabilizer utilising its high water holding capacity as in ice-cream or baking powder.

Starch has adhesive qualities which are obtained through the manufacture of modified starches and dextrins, and have a wide range of applications. In the textile industry starch is used for warp sizing to reduce breaks on looms; for cloth printing where it acts to thicken dyes and as a carrier of colour; in cloth finishing to improve stiffness and weight; and as a laundry starch. Starch and dextrin adhesives are used for the manufacture of paper bags and multiwall sacks, corrugated board, and some paper laminates, and also for labelling bottles and cans. Other uses of starch are in surgical dressings, as a binder for ceramics, in ore flocculating and oil well drilling, and in the rubber industry.

The market for starch is complex since in many uses cassava has to compete with starch from other sources such as potatoes and maize. The market for cassava starch cannot, therefore, be considered in isolation from the overall starch market. The state of the market must be considered as a separate element of any feasibility survey.

Developments in starch technology have mainly taken place in the industries of North America and Europe, and hence have been applied to the processing of products such as maize and potatoes. However, most of the preparatory stages or operations are common to all forms of starch extraction, and machinery is available for the whole process, although the scale of operation tends to be larger than is the case in traditional cassava starch processing.

The more exacting quality standards are for food grade starch and certain special starches. It was in the production of these that the application of modern techniques to the extraction of starch from cassava was first put into effect. The initiative came from outside the producing countries and represented a move to ensure supplies on the part of large concerns involved in the use of starch. Industrial grade starch has been made on primitive equipment at a small-scale of operation and in some areas this continues. Small- and medium-sized factories exist with a mixture of traditional and modern equipment, the modern equipment being confined to the more complicated and time-consuming operations.

The quality requirements for cassava starch in various importing countries and, where known, official standards are shown in Appendix I.

The essential operations which have to be performed in order to extract the starch are as follows:

washing and peeling of tubers, grinding and rasping of tubers, washing the starch out of the pulp, separating the starch from the wash-water, drying, finishing and bagging.

As with the production of chips a variety of methods have been used in undertaking these. The introduction of the diesel engine and electric motor made possible an increase in the scale of operation above that feasible by means of hand or water power.

The advantages claimed for the most up-to-date, automated systems, are the rapidity of throughput, reducing processing time from several hours or days to minutes, and the possibility of designing a closed system. The former eliminates the problem of fermentation and attendant starch loss; the latter eliminates the risk of contamination, enabling a more consistent, high quality product to be obtained. To facilitate full production planning these systems need an assured supply of tubers, which is important because of the heavy capital investment incurred. It is in relation to such plants that most interest has been expressed in the establishment of plantations to meet the need for continuity in raw material supplies.

OUTLINE OF PROCESS

On arrival at the factory the tubers are weighed on a weighbridge and unloaded from the lorry into a system of bunkers. As suggested on p. 9 it is necessary to assess the average starch content on each lorry load to facilitate the structure of payments for the tubers. There are various methods of testing the starch content, which involve taking samples from each lorry load and using some laboratory equipment.

It is essential that the utilisation of stored tubers in production be planned to ensure that tubers are used in the order of arrival. From the bunkers the tubers are taken by conveyor to the peeling and washing machine of similar construction to that used in the production of chips. The peel has to be removed in order to facilitate the rasping or grinding of the tubers; the peel has a harder, more fibrous texture than the core and is difficult to rasp. In the older, small establishments it was customary to remove all the peel; in modern factories removal is confined to the outer layer in order not to waste the starch contained by the inner peel.

From washing and peeling the tubers are conveyed to the rasping or disintegrating section. The purpose of the rasping is to rupture the cell walls in order to release the starch granules. In some processes the tubers are subject to the action of a chopper before entering the disintegrator. The disintegrator is a hopper containing a revolving drum made of longitudinal strips of hard wood between which are fitted renewable fine saw or rasp blades. The starch yield is dependent on an efficient rasping. With the most efficient, high-powered machines only one rasping is necessary; with other machines, two or more raspings may be required. The blades have to be replaced at regular intervals. Contact with iron is detrimental to the quality of the starch, and iron is therefore excluded from piping etc. in the rest of the process. Modern systems use stainless steel.

The pulp obtained from disintegration is pumped to the extraction stage where the starch milk is separated from the fibrous material. This section is generally known as screening. The basic equipment is a form of revolving screen. A wide variety of designs have been used, differing in the complexity of their construction and their efficiency of operation. To increase efficiency, the starch milk is passed through a series of extractors with sieves of increasing fineness. The operation requires that wash-water be sprayed on the pulp counter-current to the flow along the screen. In some processes fine screens are added in order to remove fine fibres. The pulp and fine fibres are led off into storage as wet waste. The waste may be pumped onto land as a fertilizer, or can be dried and sold as animal feed to local farmers.

On leaving the extractors the starch milk is stored in a crude milk tank and may be passed through a sand cyclone to remove sand and dirt particles. At the end of this stage, the starch milk has a concentration of about 54kg dry starch per m^3 (3° Bé). It is then ready for the concentration and refining stage.

In the concentration and refining stage the pure starch is separated from other material. The methods used determine the time and quality of product obtained. In the traditional method used by small enterprises the starch milk is conducted through a series of settling tanks, either of square or cylindrical shape and lined with tiles on the inside. The problem with this method is the time required to complete settling. Up to 24 hours may be required which allows contamination and fermentation by contact between the starch and the fruit water.

There is a modification of the traditional method which reduces the time required. This is the settling table, of which there are at least two types. Basically it is a flat wooden trough about 50 m long, which may be horizontal or gently sloping from the end where the starch liquid enters. The liquid flows in at a controlled rate, and the larger particles of starch separate initially, so that the starch can be graded along the length of the table. As the starch settles it builds up and increases the slope of the incline. It is necessary to periodically remove the starch when a layer up to 15cm thick has formed. This is performed either by shovel or by washing off with a hose. The settling operation may be repeated on a second table to attain a purer product. The settling table is assumed to be used in Model H of this report (see Tables 5 and 7).

The modern systems use a centrifugal separator in order to perform the separation as rapidly as possible. The starch milk may flow through two of these in succession, entering a tank with an agitator, the capacity of which allows a holding time of two hours.

On completion of separation and refining, the starch milk is ready for drying. Generally a preliminary dewatering is undertaken to reduce the moisture content to 40–45 %. The dewatering is performed by a centrifugal dryer or by a vacuum filter. Drying is undertaken by a variety of methods. Starch can be sun-dried although this method is used only in the smallest enterprises. A method applied in parts of tropical Asia is the use of an oven with a wood-fired furnace or a drying floor under which a wood-fire provides the heat for drying. By these methods the drying is completed in 12 to 24 hours. In the larger enterprises oil-fired driers are used to reduce the drying time. There are a variety of these: tunnel driers; rotary driers; and in the continuous processing systems, flash or pneumatic driers using heated, compressed air. The starch is dried to a moisture content of 10–14 %.

The process is completed by pulverizing and dry-screening the starch cake, before it is directed through a bag-filling machine. Bags should preferably be multiwall paper or jute with polythene liner; close-woven jute may be adequate for industrial starch.

The production of starch requires the addition of only two materials, water and sulphur dioxide. Washing and peeling of tubers requires crude water which should be free of sludge. For extraction processes it is recommended that a further 5.5 m^3 of cleaned water per tonne of tubers is required in a modern process. Of this about 4.5 m^3 should contain sulphur dioxide. The sulphur dioxide assists in preventing microbial activity and fermentation. The sulphur dioxide solution is prepared by burning sulphur and absorbing the gas in water to a concentration of 0.05 %. The wash-water may be recycled at various stages in the process. The above method of processing starch is assumed to be used in cost models E, F and G (Tables 5 and 7).

In considering the production of starch, an enterprise might also consider extension of the processing to the production of glucose and dextrose, or, more commonly, the production of baked grocery tapioca products such as seeds, pearls and flakes. Information about the manufacture of these products is not included in this report. Neither does it deal with tapioca flour, which is the finely ground dried material, obtained from dried chips by the simple process of milling in a hammer mill or grinding in a stone mill or mortar. It has been used in the animal feed industry and for the extraction of starch; its place in international trade is becoming of less importance compared with chips, pellets and starch.

Chapter 5

Design of cost models

CHIPS AND PELLETS – DESIGN

For the production of chips and pellets four models have been developed (see Tables 1 and 2). Models A and B illustrate the production of chips on two different scales, having inputs of 1 tonne of tubers per hour and 7 tonnes of tubers per hour respectively. The first model would correspond to a small concern, perhaps run on a family basis. The second model represents the heavier capital investment of a specialised chipping concern as found in tropical Asia. In this case the scale has been taken to correspond to that of Model C. In Model C pellets are produced from chips manufactured by the same concern. It represents an input of 2.5 tonnes per hour of dried chips into the pelleting plant, a scale which corresponds to the capacity of one pelleting press. It is thus at the lower end of the range of output feasible in a pelleting plant. Models B and C make possible a comparison of the relative profitability of continuing the process beyond chipping to pelleting.

In the three models above, and in Model D which relates to an input of 5 tonnes per hour of dried chips into the pelleting plant, the costing has been undertaken both on a one and a two shift basis. As a large proportion of the capital cost is represented by the investment in drying grounds etc, the cost tables show the capital cost corresponding to one shift output and two shift output. The time available for drying in the open is 8–12 hours a day; to dry the output of two shifts producing chips requires double the facilities for drying the output of one shift. By taking the two shifts it is possible to illustrate one effect of a curtailment in the supply of tubers, which has been emphasised as a problem in the processing of cassava. Separate calculations have been made for the return to investment on one and two shift operation and these are compared. The effect on the return of reverting from two shift to one shift production owing to shortage of supplies is also discussed.

Model D differs somewhat from the others. It illustrates the production of pellets using two pelleting presses, i.e. double the scale of Model C. On the one shift basis it is then possible to make a comparison with Model C on two shifts, illustrating the cost of obtaining the same output by different methods. Model D, however, differs from the others with respect to the costing on two shifts. At this level of output it becomes possible to envisage a specialised pelleting concern as is the case in Thailand. For this costing it is assumed that the enterprise is not concerned with the production of chips, but procures these as its primary raw material from firms who undertake the chipping and drying.

The plant is assumed to run for 5 days a week with 10 days holiday, making 250 days production time in all. A yield of 35 % of tuber weight has been taken in the case of *both* chips and pellets. To some extent this may act against the models for pelleting, as a higher yield might be obtainable if less of the peel is removed before chipping (see p. 12). It is important to bear in mind that no allowance has been made for waste and deterioration in quality. In the pelleting process a loss of 2–3 % might be expected; in the chipping process losses due to this cause are likely to be higher. In the costing no attempt has been made to apply a taxation system nor has any consideration been given to costs such as housing and medical facilities for workers. These should be borne in mind when considering investment. The costing is based on factor costs in a tropical Asian country where cassava is grown and processed.

For chipping the throughput is derived from factories in the country concerned. For pelleting the throughput is derived from machinery manufacturer's specifications. These appear to be based on a 100 % utilisation factor.

Tables 1 and 2 present an analysis of the cost models for the production of chips and pellets. Physical requirements are set out in Tables 6, 8 and 10.

COMMENTS

Table 1 shows that the enterprises producing chips would be operating at a loss. The loss incurred is due to the small margin between the cost of raw material and the price of finished product, by which processing costs have to be recovered. Such a result would not be unexpected for the country concerned where the problems of a shortage of tubers and the cost of tubers in relation to finished product price has been recognised.[11] To illustrate the effect of a lower cost of tubers a supplementary costing was undertaken and applied to Table 1. The cost of tubers was taken as £3.5 per tonne as against £4.5 per tonne in the presented model; the results are given in row 24, Table 1 and should be compared with row 23 of the same table.

Table 2 illustrates the effect of an increase in the price of the finished product of the order of 25 % while keeping the cost of material at £4.5 per tonne, with markedly improved rates of return for all models.

In the costing of Model D on two shifts, the cost of dried chips to the pelleting enterprise was taken at two levels. That at column i, Table 1 was £16 per tonne; a supplementary costing was undertaken at a price of £15 per tonne for dried chips. The rate of return derived was then 33.8 % as compared with 19.4 % in column i of Table 1. The price paid would be dependent on the industry's structure; in Thailand the large-scale pelleting enterprises are able to obtain chips at a low price from the small-scale operators producing the dried chips.[10]

The existence of economies of scale is shown for both the production of chips and pellets. The relative profitability of continuing the process into pelleting is dependent on the margin between the price for chips and that for pellets. (See p.22 for a comparison of the profitability of the production of chips and pellets). The reduction in the rate of return, by assuming a reversion to one shift production, on capital investment required for production on two shifts is shown for models A, B and C in row 7 of Table 2. These should be compared with the rates of return shown in row 6 of the same table.

The results illustrate the importance, as emphasised in Chapter 2, of ensuring an adequate supply of tubers and studying the cost of these in relation to market prospects of the finished product. The profitability of the enterprise is highly dependent on the outcome of these issues, and these should warrant careful study before undertaking any investment.

STARCH – DESIGN

Four models have been developed to illustrate the production of starch. Models E and F relate to modern factories based on continuous processing having respectively throughputs of 2 and 6 tonnes per hour. Costings are given for both two and three shifts operation. As these plants represent a heavy capital investment, full utilisation would be expected. Two shift working illustrates the effect of a shortage of tubers. In the experience of the starch industry of the developing countries, these represent medium- to large-scale enterprises, although they would be small as starch enterprises in developed countries.

Model G has been developed to illustrate the effect of obtaining supplies from a factory-owned plantation. The scale of output is that of Model F; it is assumed that the plantation would supply 50 % of the raw material required. The costing has only been undertaken on a three shift basis, since the inclusion of a plantation is intended to illustrate the effect of assuring continuity in supplies. The plantation is as in Chapter 2 and the costs derived from Tables 3 and 4.

Model H represents an attempt to cost a factory at a lower scale of output, using a less sophisticated production process. The equipment in the model is as far as possible of local construction and has been based on data from factories in the country concerned. Costings have been worked out for one, two and three shift production as such an enterprise is likely to have greater difficulty in procuring supplies than the larger enterprise with its greater contractual ability. The rate of input is 1 tonne of tubers per hour.

In addition to the production of starch, it is assumed that the wet waste is sold locally as a feed for animals. No allowance has been made for the drying of refuse pulp as is sometimes undertaken. In the costing the price has been derived from the country concerned, applicable to sale of wet waste rather than dry waste. The wet waste content is taken as 10 % of the tuber weight, having a 75–80 % moisture content.[4]

The plant is assumed to have a production time of 290 days a year in all cases. A yield of commercial starch at 12 % moisture content of 23 % of tuber weight has been assumed. In the costing no attempt has been made to apply a taxation system, nor has any consideration been given to costs such as housing and medical facilities for workers. These should be borne in mind when considering investment. The costing is based on the same tropical Asian country as in the case of the models for the production of chips and pellets.

The throughput is derived from machinery manufacturer's specifications. These appear to be based on a utilisation factor of 100 %.

Table 5 presents an analysis of the cost models for the production of starch. Physical requirements are set out in Tables 7, 9 and 11.

COMMENTS

The results in Table 5 show the financial problem of operation for these enterprises at the assumed cost of tubers and final product price, which implies a low margin for processing costs and profit.

The modern factory with heavy investment in a continuous processing system shows a reasonable rate of return only on the larger scale (Models F and G) and at full utilisation of plant. For output at a small-scale, the enterprise with traditional equipment (Model H) appears to have an economic advantage, in comparison with Model E, if it is able to obtain sufficient cassava to run three shifts. The costing of Model H is, however, an approximation.

Taking a uniform yield for all models may place Models E, F and G at a disadvantage as these are capable of attaining an efficiency of over 90 % in extracting starch of a consistently high quality. A yield of 23 % of tuber weight from tubers with a total starch content of 26 % represents an extraction efficiency of 88 %. Taking an extraction efficiency of 96 % would give an output of commercial starch of 25 % of tuber weight. A supplementary costing was undertaken to show the effect of such a yield for Models E, F and G. It would also be considered, for purposes of comparison, as showing the effect of a variety of tuber having a higher starch content, at the original efficiency level of 88 per cent in extracting the starch. The results of these modifications for Models E, F and G are shown at row 29, Table 5, and should be compared with row 28 of the same table.

PROFITABILITY OF CHIPS, PELLETS OR STARCH COMPARED

In this section the results of the analysis have been brought together and summarised to present for each model the rate of return as given in Tables 1, 2 and 5 and the net present value. The net present value is derived by discounting the annual cash flow of the model at an appropriate discount rate over the life of the plant and equipment: the resultant figure is deducted from the capital cost of the model to obtain the net present value. The annual cash flow is represented by the figures for operating surplus or loss in Tables 1, 2 and 5. A discount rate of 8 % has been used over a period of 13 years (an approximation for the life of the plant and equipment derived from a depreciation rate of 7.5 % per annum). The advantage of calculating the net present value is that it takes account of the different magnitude of capital investment between projects as well as earnings, which the rate of return method does not.[12] [13] To facilitate a comparison of the profitability of the models the results have been tabulated below. In general, a project with a higher net present value is considered a more favourable investment proposition.

A number of comparisons can be made as to the profitability of different products. The production of pellets appears a more favourable investment proposition than that of chips, comparing models 2B and 2C on two-shift operation. This comparison also shows the advantages of the net present value method, for by a rate of return approach model 2B represents a higher return but derived from a smaller amount of capital investment to give a smaller absolute annual cash flow than model 2C. On the same basis of two-shift operation, the production of pellets is also more favourable than that of starch, models 1C, 2C and 5F. However, the profitability of the starch enterprise at full capacity of three-shift operation is greater than that of pellets at model 1C but not at model 2C (on two-shift operation), the latter representing a higher revenue assumption for chips and pellets. In order to assess the relative profitability of obtaining a proportion of supplies of cassava from a factory-owned plantation, models 5F (three-shift operation) and 5G can be compared, indicating the ‘with plantation’ model as a more favourable investment proposition by net present value although the rate of return does not differ greatly. The model with the plantation could be considered as an investment in risk aversion in order to avoid the results obtained for model 5F on one or two-shift operation, due to a curtailment in supplies of cassava. As such it is a heavy capital investment which should be phased carefully over the first 2 or 3 years.

The prices of raw materials and finished products used in this report were obtained in 1971. Since that time there has been a substantial increase in the price of products based on primary commodities. In order to illustrate the effect of these prices as at mid-1973 were obtained from the source in the same South-East Asian country. A comparison can be made of the margin between the price of the finished product per tonne and the cost of cassava tubers required to produce a tonne of the finished product. This margin has to cover processing costs and any profit from the activity. Such a margin has been tabulated below, both for the prices used throughout this report and for the mid-1973 prices. In the case of chips and pellets two revenue assumptions were taken in the report (Tables 1 and 2) from different sources in the country: these are shown at rows 1, 2, 4 and 5.

Table 5.1

Net present value (NPV) of models

Table and model	Product	Number of shifts per day	Capital cost	Annual cash flow	NPV at 8 %	Rate of return[1] %
a	b	c	d	e	f	g
1A	chips	1	8 230	– 1 740	– 21 990	–26.6
1A	chips	2	13 080	– 2 450	– 32 430	–24.0
1B	chips	1	53 630	– 3 190	– 78 830	–12.0
1B	chips	2	91 140	– 2 920	–114 210	– 9.0
1C	pellets	1	113 010	8 540	– 45 530	1.3
1C	pellets	2	151 620	24 090	38 770	9.9
1D	pellets	1	173 440	26 220	33 770	9.0
1D	pellets (chips bought)	2	138 880	32 760	120 020	19.4
2A	chips	1	8 230	1 060	140	7.4
2A	chips	2	13 080	3 150	11 820	18.8
2B	chips	1	53 630	16 410	76 060	24.5
2B	chips	2	91 140	36 280	195 600	34.0
2C	pellets	1	113 010	23 240	70 640	14.3
2C	pellets	2	151 620	53 490	271 130	29.3
2D	pellets	1	173 440	55 620	266 140	26.0
5E	starch	2	173 500	2 530	–153 510	– 4.6
5E	starch	3	173 500	11 670	– 81 290	0.7
5F	starch	2	362 660	27 630	–144 290	1.8
5F	starch	3	362 660	60 690	116 980	12.0
5G	starch (with plantation)	3	537 360	101 040	261 160	11.5
5H	starch	1	32 460	– 1 980	– 48 130	–11.5
5H	starch	2	32 460	1 160	– 23 290	– 1.8
5H	starch	3	32 460	4 230	990	7.7

Footnote: (1) Row 23, Table 1; row 6, Table 2; row 28, Table 5.

Table 5.2

Comparison of margins in South-East Asia, 1971 and 1973

	Cost of tubers per tonne of dried chips £	Price per tonne of dried chips £	Margin £	Margin as a % of sales revenue col d÷col c %
a	b	c	d	e
1 South-East Asia, 1971 (Table 1)	13	16	3	18.8
2 South-East Asia, 1971 (Table 2)	13	20	7	35.0
3 South-East Asia, 1973	25	28	3	10.7
	Cost of tubers per tonne of pellets £	Price per tonne of pellets £	Margin £	Margin as a % of sales revenue %
4 South-East Asia, 1971 (Table 1)	13	20	7	35.0
5 South-East Asia, 1971 (Table 2)	13	23	10	43.5
6 South-East Asia, 1973	25	32	7	22.0
	Cost of tubers per tonne of starch £	Price per tonne of starch £	Margin £	Margin as a % of sales revenue %
7 South-East Asia, 1971	19.5	36	16.5	46.0
8 South-East Asia, 1973	38	60	22	36.7

The conclusion appears to follow from the above that the effect of a rise in world prices for a country exporting cassava products has been to benefit the producers of cassava to a greater extent than the processors.

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Tables

Table 1

Capital and annual operating costs, financial analysis: production of chips and pellets[1]

Values in £ sterling 1972–73

	Item	Model A 700 tonnes per shift per year, dried chips		Model B 4 900 tonnes per shift per year, dried chips		Model C 4 900 tonnes per shift per year, pellets		Model D 9 800 tonnes per shift per year, pellets	
		1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts
	a	b	c	d	e	f	g	h	i
	Capital costs								
1	Land and site preparation	1 340	2 140	7 510	13 320	12 670	18 360	20 280	8 380
2	Buildings and structures	960	1 660	5 600	10 700	5 950	9 800	9 800	8 000
3	Concrete drying grounds	1 750	3 500	12 500	25 000	12 500	25 000	25 000	–
4	Plant and equipment	2 100	2 100	13 700	15 500	58 250	60 050	77 620	63 500
5	Installations and unforeseens	320	320	2 060	2 320	18 740	9 010	11 640	9 520
6	Total fixed capital	6 470	9 720	41 370	66 840	98 110	122 220	144 340	89 400
7	Working capital	1 760	3 360	12 260	24 300	14 900	29 400	29 100	49 480
8	Total investment	8 230	13 080	53 630	91 140	113 010	151 620	173 440	138 880
	Annual operating costs								
9	Raw material	9 000	18 000	63 000	126 000	63 000	126 000	126 000	320 000
10	Personnel	2 230	3 550	7 420	12 120	9 120	14 470	13 360	5 940
11	Electricity	430	860	2 160	4 320	7 560	15 120	13 180	17 710
12	Sacks	820	1 640	5 760	11 520	3 850	7 700	7 700	15 320
13	Water	190	380	1 300	2 600	1 300	2 600	2 600	20
14	Fuel and oil	–	–	100	150	110	170	170	10
15	Insurance, personnel and fire	50	70	320	440	1 000	1 100	1 350	1 100
16	Spares and maintenance	80	80	550	620	2 330	2 400	3 100	3 175
17	Interest on working capital	140	270	980	1 950	1 190	2 350	2 320	3 960
18	Total	12 940	24 850	81 590	159 720	89 460	171 910	169 780	367 240
	Financial analysis								
19	Revenue	11 200	22 400	78 400	156 800	98 000	196 000	196 000	400 000
20	Operating surplus or loss (–)	–1 740	–2 450	–3 190	–2 920	8 540	24 090	26 220	32 760
21	Depreciation	450	690	3 270	5,310	7 040	9 000	10 480	5 830
22	Net profit or loss before tax	–2 190	–3 140	–6 460	–8 230	1 500	15 090	15 740	26 930
23	Rate of return or loss (–) before tax on investment	–26.6%	–24.0%	–12.0%	–9.0%	1.3%	9.9%	9.0%	19.4%
24	Rate of return or loss (–) before tax on investment, alternative cost of tubers	–2.3%	6.5%	14.0%	21.7%	13.7%	28.4%	25.2%	–

Footnotes:

(1) See notes on opposite page

– Not applicable

Notes on table 1

Row 1: Land in rural area, see row 1, Table 6.
Site preparation taken as 10 % of rows 2 to 5, Table 1 and 10 % of land, row 1, Table 6.
Row 2: See Table 6, rows 2 to 7.
Row 3: See Table 6, row 8.
Row 4: See Table 6, rows 9, 10 and 11.
Row 5: 15 % of row 4.
Row 6: Sum of rows 1 to 5.
Row 7: Working capital on the following basis.
Models A and B: 1½ days' stock of tubers; 5 days' work in progress – chips in the process of drying; 1 month's operating expenses, other than tubers; 1 month's finished product.
Model C and D (col h): as above, plus 1 day's work in progress – dried chips in store as input for pelleting plant.
Model D (col i): 1 week's stock of dried chips; 1 month's operating expenses other than dried chips; 1 month's finished product.
Row 8: Row 6 plus row 7.
Row 9: See Table 8, rows 1 and 2.
Row 10: See Table 10.
Row 11: See Table 8, row 3.
Row 12: See Table 8, row 4.
Row 13: See Table 8, row 5.
Row 14: See Table 8, row 6.
Row 15: Fire insurance at 1.5 % value of buildings and plant; personnel at 0.4 % of wage bill.
Row 16: 5 % of row 4.
Row 17: 8 % of row 7.
Row 18: Sum of rows 9 to 17.
Row 19: Prices ex-factory derived from tropical Asian country:
Chips at £16 per tonne (cols b to e)
Pellets at £20 per tonne (cols f to i).
Row 20: Row 19 minus row 18.
Row 21: Derived from rows 1 to 4 using the following rates of depreciation:–
Buildings and structures at 5 % per annum.
Plant and equipment at 7.5 % per annum.
Vehicles at 10 % per annum (Table 6).
Land and concrete works amortised at 8 % per annum.
Row 22: Row 20 minus Row 21.
Row 23: Row 22 as a percentage of row 8.
Row 24: Tubers at a cost of £3.5 per tonne expressed as a percentage of row 8.

Table 2

Financial analysis, higher revenue assumption: production of chips and pellets[1]

Values in £ sterling 1972–73

	Item	Model A 700 tonnes per shift per year, dried chips		Model B 4 900 tonnes per shift per year, dried chips		Model C 4 900 tones per shift per year, pellets		Model D 9 800 tonnes per year, pellets
		1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts	1 shift
	a	b	c	d	e	f	g	h
1	Revenue	14 000	28 000	98 000	196 000	112 700	225 400	225 400
2	Operating costs	12 940	24 850	81 590	159 720	89 460	171 910	169 780
3	Operating surplus or loss (–)	1 060	3 150	16 410	36 280	23 240	53 490	55 620
4	Depreciation	450	690	3 270	5 310	7 040	9 000	10 480
5	Net profit or loss (–) before tax	610	2 460	13 140	30 970	16 200	44 490	45 140
6	Rate of return or loss (–) before tax on capital investment	7.4%	18.8%	24.5%	34.0%	14.3%	29.3%	26.0%
7	Rate of return or loss (–) before tax on capital investment for two shift production	4.7%	–	14.4%	–	10.7%	–	–

Footnote:

(1) See notes on opposite page

Notes on table 2

Row 1:	Prices ex-factory derived from tropical Asian country:– Chips at £20 per tonne (cols b to e); Pellets at £23 per tonne (cols f to h).
Row 2:	Row 18, Table 1.
Row 3:	Row 1 minus row 2.
Row 4:	Row 21, Table 1.
Row 5:	Row 3 minus row 4.
Row 6:	Row 5 as a percentage of row 8, Table 1.
Row 7:	Row 5 as a percentage of columns, c, e, g. of row 8, Table 1.

Table 3

Capital and annual operating costs for plantation

Values in £ sterling 1972–73

	Item	21 000 tonnes of tubers per year	Notes
	a	b	c
	Capital costs		
1	Development costs	128 000	1 280 hectares @ £100 per hectare. Amortisation rate = 8 % per annum
2	Equipment, field operations	22 700	See Table 4, rows 1 to 4
3	Transport equipment	18 000	Four 10 ton lorries @ £4 500 each. Depreciation rate: 10 % per annum
4	Buildings etc	2 500	Assumed from data. Depreciation rate: 5 % per annum
5	Total fixed capital	171 200	Sum of rows 1 to 4
6	Working capital	4 500	1 month's operating expenses
7	Total investment	175 700	Sum of rows 5 and 6
	Annual operating costs		
8	Plant material	1 960	700 hectares @ £2.8 per hectare
9	Fertiliser	3 500	700 hectares @ £5 per hectare
10	Harvesting	21 000	Contract work: 21 000 tonnes @ £1 per tonne
11	Personnel	17 440	See Table 4, rows 5–14
12	Fuel and oil	2 400	Diesel fuel @ £0.095 per gallon: 22 400 gallons. Lubricants assumed at £250
13	Rent	4 300	1 280 hectares @ £3.36 per hectare, available from government
14	Insurance, licences etc	1 200	1.5 % on buildings, equipment; 0.4 % on wage bill. Licences assumed at £500
15	Spares and maintenance	2 000	5 % of (row 2 plus row 3)
16	Interest on working capital	360	8 % of row 6
17	Total	54 160	Sum of rows 8 to 16
18	Depreciation	18 120	See notes on Table 4 and rows 1, 3 and 4
19	Cost per tonne of tubers, delivered	£3.44	Row 17 plus row 18 ÷ 21 000

Table 4

Field equipment and personnel requirements for plantation

Values in £ sterling 1972–73

	Item	No	Unit cost	Total cost	Notes
	a	b	c	d	e
	Field equipment				
1	Ford 400 tractor, coupled with Bonner single row planter	1	2 200	2 200	Depreciation rate: 20 % per annum
2	Caterpillar D5 SA tractor coupled with Rome TRH 16–30 plough	1	17 000	17 000	Depreciation rate: 25 % per annum
3	Additional attachment to Caterpillar: Rome 3 point lifter, Rome swinging drawbar etc for ridging	1	2 000	2 000	Depreciation rate: 25 % per annum
4	Kubota MP11 power tillers	3	500	1 500	Depreciation rate: 50 % per annum
	Personnel				
5	Manager	1	1 870	1 870	
6	Clerical	1	640	640	
7	Foreman	3	600	1 800	
8	Mechanics	2	600	1 200	
9	Equipment operators	5	300	1 500	
10	Assistants	5	160	800	
11	Lorry drivers	4	400	1 600	
12	Assistants	4	200	800	
13	Labourers (weeding)	40	160	6 400	
14	Employees Provident Fund	–	–	830	5 % of wage bill
15	Total, personnel	65	–	17 440	Sum of rows 5 to 14

Table 5

Capital and annual operating costs, financial analysis: production of starch[1]

Values in £ sterling 1972–73

	Item	Model E 1 075 tonnes per shift per year, starch		Model F 3 225 tonnes per shift per year, starch		Model G[2] 9 675 tonnes per year, starch	Model H 535 tonnes per shift per year, starch		
		2 shifts	3 shifts	2 shifts	3 shifts	3 shifts	1 shift	2 shifts	3 shifts
	a	b	c	d	e	f	g	h	i
	Capital costs								
1	Land and site preparation	14 500	14 500	30 760	30 760	30 760	2 900	2 900	2 900
2	Buildings and structures	14 600	14 600	36 600	36 600	36 600	5 100	5 100	5 100
3	Plant and equipment	109 000	109 000	221 500	221 500	221 500	16 000	16 000	16 000
4	Installations and unforeseens	16 000	16 000	33 200	33 200	33 200	2 400	2 400	2 400
5	Total fixed capital, factory	154 100	154 100	322 060	322 060	322 060	26 400	26 400	26 400
6	Working capital, factory	19 400	19 400	40 600	40 600	40 600	6 060	6 060	6 060
7	Total investment, factory	173 500	173 500	362 660	362 660	362 660	32 460	32 460	32 460
8	Fixed capital, plantation	–	–	–	–	170 200	–	–	–
9	Working capital, plantation	–	–	–	–	4 500	–	–	–
10	Total investment, plantation	–	–	–	–	174 700	–	–	–
11	Total investment	173 500	173 500	362 660	362 660	537 360	32 460	32 460	32 460
	Annual operating costs								
12	Raw material	42 270	63 410	126 840	190 240	95 740	10 510	21 020	31 530
13	Personnel	11 500	14 780	24 190	29 280	29 280	6 450	9 570	12 760
14	Electricity	6 000	9 000	16 500	24 400	24 400	1 400	2 800	4 200
15	Sacks	2 740	4 170	8 230	12 500	12 500	680	1 360	2 040
16	Water	2 750	4 150	8 290	12 430	12 430	690	1 380	2 070
17	Fuel and oil	4 000	5 000	11 970	15 110	15 110	750	1 310	1 870
18	Insurance, fire and personnel	1 860	1 860	3 990	3 990	3 990	300	300	300
19	Spares and maintenance	5 400	5 400	11 100	11 100	11 100	800	800	800
20	Interest on working capital	1 550	1 550	3 260	3 260	3 260	500	500	500
21	Total, factory	78 070	109 320	214 370	302 310	207 810	22 080	39 040	56 070
22	Operating costs, plantation	–	–	–	–	54 150	–	–	–
23	Total	78 070	109 320	214 370	302 310	261 960	22 080	39 040	56 070
	Financial analysis								
24	Revenue	80 600	120 990	242 000	363 000	363 000	20 100	40 200	60 300
25	Operating surplus or loss (–)	2 530	11 670	27 630	60 690	101 040	–1 980	1 160	4 230
26	Depreciation	10 530	10 530	21 240	21 240	39 350	1 740	1 740	1 740
27	Net profit or loss (–) before tax	–8 000	1 140	6 390	43 450	61 690	–3 720	–580	2 490
28	Rate of return or loss (–) before tax on capital investment	–4.6%	0.7%	1.8%	12.0%	11.5%	–11.5%	–1.8%	7.7%
29	Rate of return or loss (–) before tax on capital investment, assuming higher yield of starch	–2.9%	3.1%	7.2%	19.1%	17.0%	–	–	–

Footnotes:

(1) See notes on opposite page

(2) Model G includes a plantation

Notes on table 5

Row 1: Land in rural area, see row 1, Table 7. Site preparation taken as 10 % of rows 2 to 4, Table 5 and 10 of row 1, Table 7.
Row 2: See Table 7, rows 2 to 4.
Row 3: See Table 7, rows 5, 6 and 7.
Row 4: 15 % of row 3.
Row 5: Sum of rows 1 to 4.
Row 6: Working capital on the following basis:—
1½ days' stock of tubers: 1 month's finished product, starch: 1 week's finished product, wet waste; 1 month's operating expenses.
Row 7: Row 5 plus row 6.
Row 8: Row 5, Table 3.
Row 9: Row 6, Table 3.
Row 10: Row 8 plus row 9.
Row 11: Row 7 plus row 10.
Row 12: See Table 9, rows 1 and 2.
Row 13: See Table 11.
Row 14: See Table 9, row 3.
Row 15: See Table 9, row 4.
Row 16: See Table 9, row 5.
Row 17: See Table 9, rows 6 and 7.
Row 18: Fire insurance at 1.5 % value of buildings and plant: personnel at 0.4 % of wage bill.
Row 19: 5 % of row 3.
Row 20: 8 % of row 6.
Row 21: Sum of rows 12 to 20.
Row 22: Row 17, Table 3.
Row 23: Row 21 plus row 22.
Row 24: Starch at £36 per tonne. Wet waste at £3.5 per tonne, assumed as 10 % of weight of tuber input.
Row 25: Row 24 minus row 23.
Row 26: Models E, F and G derived from rows 1 to 3 using the following rates of depreciation:—
Buildings and structures at 5 % per annum.
Plant and equipment at 7.5 % per annum.
Vehicles at 10 % per annum.
Land amortised at 8 % per annum.
Model G as above plus depreciation of plantation, row 18, Table 3.
Row 27: Row 25 minus row 26.
Row 28: Row 27 as a percentage of row 11.
Row 29: Yield of starch at 25 % of total tuber weight, giving alternative total revenue for columns b to f respectively: £83 540; £125 290; £261 800; £392 700; £392 700.

Table 6

Capital requirements: production of chips and pellets[1]

Values in £ sterling 1972–73

	Item	Cost	Model A		Model B		Model C		Model D	
			1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts
	a	b	c	d	e	f	g	h	i	j
1	Land	£500 per acre	1.5 acres	2.5 acres	7.5 acres	14.5 acres	7.5 acres	14.5 acres	14.5 acres	0.5 acres
	Buildings and structures									
2	Tuber reception	£ 4 per m^2	10 m^2	19 m^2	68 m^2	136 m^2	68 m^2	136 m^2	136 m^2	—
3	Factory structure, chipping	£ 5 per m^2	50 m^2	50 m^2	100 m^2	100 m^2	100 m^2	100 m^2	100 m^2	—
4	Factory structure, pelleting	£10 per m^2	—	—	—	—	150 m^2	150 m^2	150 m^2	150 m^2
5	Storage of dried chips	£ 5 per m^2	—	—	—	—	16 m^2	32 m^2	32 m^2	440 m^2
6	Storage of finished product	£ 5 per m^2	64 m^2	128 m^2	470 m^2	940 m^2	220 m^2	430 m^2	430 m^2	860 m^2
7	Shed for chips during drying	£ 1 per m^2	350 m^2	700 m^2	2 500 m^2	5 000 m^2	2 500 m^2	5 000 m^2	5 000 m^2	—
8	Concrete drying ground	£2 000 per acre	3 500 m^2	7 000 m^2	25 000 m^2	50 000 m^2	25 000 m^2	50 000 m^2	50 000 m^2	—
9	Equipment for chipping[2]	—	£ 2 100	£2 100	£10 100	£10 100	£7 900	£7 900	£10 000	£1 500
	Tuber washer and peeler[3] with motor	—	1 tonne per hour	1 tonne per hour	7 tonnes per hour	7 tonnes per hour	7 tonnes per hour	7 tonnes per hour	14 tonnes per hour	—
	Tuber chipper[3] with motor	–	1 tonne per hour	1 tonne per hour	7 tonnes per hour	7 tonnes per hour	7 tonnes per hour	7 tonnes per hour	14 tonnes per hour	—
	Water tank, piping and pump									—
	Conveyors, weighbridge									—
	Miscellaneous									—
10[4]	Equipment for pelleting		—	—	—	—	£46 750	£46 750	£61 220	£62 000
	Hoppers[3]		—	—	—	—	2	2	3	3
	Bins[3]		—	—	—	—	3	3	1	1
	Overbelt magnetic separator		—	—	—	—	1	1	1	1
	Selenium rectifier		—	—	—	—	1	1	1	1
	Vibration screen		—	—	—	—	1	1	1	1
	Root crusher for cassava		—	—	—	—	1	1	1	1
	Belt conveyors with motors		—	—	—	—	2	2	3	3
	Level indicators		—	—	—	—	1	1	1	1
	Trough chain conveyor		—	—	—	—	1	1	1	1
	Distributing screw		—	—	—	—	1	1	2	2
	Feed worm		—	—	—	—	1	1	2	2
	Pelleting press		—	—	—	—	1	1	2	2
	Driving motor for pelleting press		—	—	—	—	1	1	2	2
	Outlet pipe		—	—	—	—	1	1	1	1
	Chuting screen		—	—	—	—	1	1	1	1
	Belt cooler		—	—	—	—	1	1	1	1
	Ventilator for generating the cooling air		—	—	—	—	1	1	1	1
	Gross weigher sacker		—	—	—	—	1	1	1	1
	Meal return screw		—	—	—	—	1	1	1	1
	Ventilator		—	—	—	—	1	1	1	1
	Pulley block with trolley		—	—	—	—	1	1	2	2
	Water injection device		—	—	—	—	1	1	1	1
	Steam boiler		—	—	—	—				
	Piping		—	—	—	—				
	Supports for machinery		—	—	—	—				
	Switch board		—	—	—	—				
11	Tractors (MF135 size)	£1 800	—	—	2	3	2	3	3	—

Footnotes:

(1) See notes on opposite page

(3) Of local construction

Notes on table 6

Row 2: Density of tubers taken as 0.625 kg/m^3 (1 tonne = 1.6m^3). Assumed that the maximum storage of tubers is 1½ days' production needs, stored in a system of concrete bunkers at a height of 2 metres.

Row 3: Simple structure to cover operations of washing, peeling and chipping. Wooden support frame, corrugated iron roof.

Row 4: More elaborate structure for the pelleting plant; reinforced walls with tiled roof. Maximum 14 m high.

Row 5: Simple structure with wooden support frame, corrugated iron roof.

Row 6: As row 5.

Row 7: Assumed as 10 % of the drying area.

Row 8: Assumed that 250 m^2 is required for 1 tonne per day dried products. The figure has been derived from experiments in Madagascar. However, in this case drying was done on trays in the open and not on concrete. The above figure should be treated with caution.[4, 14]
As assumed average drying time of 5 days has been taken.
1 tonne of dried chips over 5 days requires 1 250 m^2.
A figure of £2 000 per acre was taken for concrete works from data in the country concerned; the figure should be treated with caution (approx. 4 000 m^2 = 1 acre).
Area required for drying: output per day x 1 250 m^2. (The figure should be adjusted according to local climatic conditions and time expected for drying).

Row 9: Derived from local cost data.

Row 10: Derived from quotation by European manufacturer plus sea-freight and transport to site; some items of equipment to be locally constructed.

Row 11: Derived from local cost data.

Table 7

Capital requirements: production of starch

Values in £ sterling 1972–73

	Item	Cost	Model E	Model F	Model G	Model H
	a	b	c	d	e	f
1	Land	£500 per acre	1 acre	3 acres	3 acres	1 acre
	Buildings and structures					
2	Tuber reception	£ 4 per m^2	58 m^2	173 m^2	173 m^2	29 m^2
3	Factory, including storage	£10 per m^2	–	–	–	500 m^2
4	Factory, including storage	£12 per m^2	1 200 m^2	3 000 m^2	3 000 m^2	–
	Transport equipment					
5	5 ton lorry	£2 000 each	–	–	–	1
6	10 ton lorry	£4 500 each	1	3	3	–
7	Equipment for starch plant	–	£104 500	£208 000	£208 000	£14 000

Notes on table 7

Row 2: As in Notes to Table 6, row 2.
Row 3: Structure with reinforced walls and tiled roof, as row 4, Table 6.
Row 4: Structure with reinforced walls and tiled roof. Maximum 16 metres high.
Row 5: From local cost data.
Row 6: From local cost data.
Row 7: Derived from quotations from European manufacturers plus sea-freight and transport to site. Model H includes equipment constructed locally as well as imported items; the costs for the local items are estimates derived from data for the country concerned. Details of equipment are listed on the following page.

Details of equipment

Models E, F, G

Weighbridge
Laboratory tuber washer
Specific gravity scale
Tuber band conveyor
Tuber lifter
Band conveyor for waste
Tuber weighing and dosage device
Tuber peeler and washer
Tuber chopper
Screw conveyor
Tuber disintegrator
Pulp pump
Multi-stage starch extractor with sieve, cones, pumps
Multi-stage starch extractor for fine screening
Tank for crude starch milk
Feed pump
Sand cyclone
Starch separator
Pump for starch concentrate
Flow meter for effluent
Flow meter for wash water
Starch separator
Flow meter for wash water
Pump for starch concentrate
Tank with agitator for refined starch milk
Pump for refined starch milk
Continuous vacuum filter
Flash drier
Starch control sifter
Silo for final starch
Bag filling machine
Absorption tower
Static pan burner with cooling jacket
Air compressor with tank, air filter, valve
Wooden tank for sulphur dioxide solution
High-level tank of wood for sulphur dioxide solution distribution
Pump
Motors and starters
Interconnecting process piping
Utility piping
Electric control cabinets
Water tank and piping
Fuel oil storage
Other conveyors

Model H

Weighbridge
Specific gravity scale

Tuber conveyor and lifter
Tuber weighing and dosage device
Tuber peeler and washer

Tuber grater with exchange drum

Pulp pump
3 washing sieves for screening

4 agitators and pumps
Flow spouts
2 settling tables
Tank for starch milk

Pump
Vacuum filter
Drying oven or floor
Mill for grinding
Starch sifter, bag filling machine

Absorption tower
Sulphur furnace with filler cap, water cooling
Air compressor
Wooden tank for sulphur dioxide solution

Motors and starters
Water tank and piping
Fuel oil storage
Other conveyors

Table 8

Raw material and other inputs: production of chips and pellets

Values in £ sterling 1972–73

Item	Unit cost	Model A Per shift per year	Model B Per shift per year	Model C Per shift per year	Model D		Notes
					1 shift per year	2 shifts per year	
a	b	c	d	e	f	g	h
1 Tubers	£4.5 per tonne	2 000 tonnes	14 000 tonnes	14 000 tonnes	28 000 tonnes	–	At factory cost
2 Dried chips	£16 per tonne	–	–	–	–	20 000 tonnes	At factory cost
3 Electricity	£0.0108 per kWh	40 000 kWh	200 000 kWh	700 000 kWh	1 220 000 kWh	820 000 kWh	
4 Sacks	£0.047 each	17 500	122 500	81 830	163 660	326 000	Second-hand gunny sacks holding 40 kg of chips or 60 kg of pellets
5 Water	£0.037 per '000 litres	5 000 000 litres	35 000 000 litres	35 156 000 litres	70 312 000 litres	624 000 litres	Washing and peeling: 2 500 litres per tonne of tubers. Pelleting: 156 000 litres for steam raising per shift of 2.5 tonnes per hour
6 Fuel and oil	£0.0208 per litre	–	2 490 litres per tractor per year	2 490 litres per tractor per year 25 litres per shift	2 490 litres per tractor per year 50 litres	– 100 litres	Pelleting plant: 25 litres per shift of 2.5 tonnes per hour

Table 9

Raw material and other inputs: production of starch

Values in £ sterling 1972–73

Item	Unit cost	Model E	Models F and G	Model H	Notes
		Per shift per year	Per shift per year	Per shift per year	
a	b	c	d	e	f
1 Tubers	£4.5 per tonne	4 660 tonnes	14 000 tonnes	2 320 tonnes	At factory cost
2 Sulphur	£27 per tonne	5 tonnes	15 tonnes	2.5 tonnes	1.1 kg per tonne of tubers
3 Electricity	£0.0108 per kWh	280 000 kWh	765 000 kWh	130 000 kWh	
4 Sacks	£0.058 each	23 600	70 900	11 800	Paper (6 ply) holding 45 kg of starch
5 Water	£0.037 per '000 litres	37 280 000 litres	112 000 000 litres	18 600 000 litres	8 000 litres per tonne of tubers, clean water. Not costed: 5 000–15 000m^3 of additional crude water (drawn from river)
6 Firewood	£1.4 per tonne	–	–	400 tonnes	Starch drying oven
7 Fuel and oil	£0.0208 per litre	2 shifts: 192 000 litres. 3 shifts: 238 000 litres	2 shifts: 573 300 litres. 3 shifts: 722 300 litres	9 100 litres	Oil for drying and fuel for vehicles

Table 10

Personnel: production of chips and pellets

Values in £ sterling 1972–73

Item	Unit cost, per year £	Model A		Model B		Model C		Model D	
		1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts	1 shift	2 shifts
a	b	c	d	e	f	g	h	i	j
1 Manager (owner)	1 000	1	1	—	—	—	—	—	—
2 Manager/technician	1 870	—	—	1	1	1	1	1	1
3 Clerical	550	—	—	1	1	1	1	1	1
4 Foreman	500	—	—	3	6	4	6	5	2
5 Tractor drivers	175	—	—	2	3	2	3	3	—
6 Labourers	140	8	17	20	40	28	56	52	16
7 Employees Provident Fund	5 % of wage bill								

Table 11

Personnel: production of starch

Values in £ sterling 1972–73

Item	Unit cost, per year £	Model E		Model F		Model G	Model H		
		2 shifts	3 shifts	2 shifts	3 shifts	3 shifts	1 shift	2 shifts	3 shifts
a	b	c	d	e	f	g	h	i	j
1 General manager	3 000	—	—	1	1	1	—	—	—
2 Manager/technician	1 870	1	1	1	1	1	1	1	1
3 Clerical	640	2	2	3	3	3	1	1	2
4 Laboratory worker	600	1	1	1	1	1	—	—	—
5 Foremen (process)	600	2	3	2	3	3	—	—	—
6 Foremen (other)	600	2	3	4	4	4	1	2	3
7 Mechanics	600	2	3	4	6	6	1	2	2
8 Lorry driver	400	1	1	3	3	3	1	1	1
9 Assistant	200	1	1	3	3	3	1	1	1
10 Operatives	400	4	6	10	15	15	1	2	3
11 Labourers	175	8	11	22	28	28	8	16	24
12 Employees Provident Fund	5% of wage bill								

Appendix 1

Commercial requirements and official standards for cassava products

Jean S Ingram

Quality assessment of cassava for either the international trade or use in the country of origin is usually based on certain physical and chemical features of the product concerned. Desirable properties are a good white or light colour, adequate dryness, and absence of foreign material, insect infestation and mould damage. Although there have been instances[1] of high bacterial contamination in cassava chips and flour for animal feeds, bacterial count is not usually determined in analytical data. Pramanik[2] however states that it should not exceed 10 million per g of material. Chemical considerations are starch, ash, moisture and fibre contents.

The above measures are generally applied to cassava in the world trade. Official standards for specific products however eg chips, flour, etc exist in only a few countries. Moreover quality standards for a particular purpose may vary between countries as individual markets differ in their attitudes or preferences regarding quality.

Chips, flour and pellets produced in Thailand are exported mainly to Europe viz West Germany, the Netherlands and Belgium where they are used in the animal feedingstuffs industry. These countries are quality conscious and large scale manufacturers and cooperatives definitely prefer a high quality product. Thailand has therefore defined scientific standards[3] for chips (2 grades) and flour respectively, and the analyses conform by law to meet the requirements of the compound animal feedingstuffs industry of the respective countries. Thailand also specifies[3] the type of packaging required of chips and flour for export. They should be exported in gunny bags which are in a good, sound state and suitable for transport, ie without breaks, leaks, or insect infestation. The bags must also be free of any odours that may affect the quality of the contents. The mouth of the bags is then tightly sewn across and reverse with at least eleven stitches each way with double jute twine. There are special requirements for pellets also, [1,2,4] as shown in Table 1. India has scientific specifications for chips,[5,6] flour[7,8,9] and starch[10,11] for use in the Indian food, animal feeding and cotton textile industries respectively. Lavigne[12] has given definitions of physical data for chips and flour produced in Madagascar, destined for French markets. Tanzania[1] also has specified properties of cassava chips for the export market. Users of cassava starch however, in the food, paper and textile industries respectively have their own individual specifications which meet the properties required for particular end-uses. In the United States, regulations for cassava starch and flour for the food industry are reported to be based largely on those published by the Tapioca Institute of America[13,14]. In Sri Lanka[15] one paper mill has specified requirements of cassava starch for its own use. There are no official standards for cassava in the United Kingdom[16] but desirable qualities are a clean white product, free from insect infestation and mould.

For high grade starch the moisture content should not exceed 12 %.

Commercial requirements for cassava in importing or exporting countries and, where known, official standards are presented country by country in Tables 1 and 2 respectively.

Table 1

Specifications for chips, flour, pellets

	Thailand					India					Tanzania	Madagascar
	Chips^3		Flour^3		Pellets^{1,2,4} *	Chips^{5,6}		Flour^{7,8,9}			Chips^1	Chips^{12}
	Special grade	First grade	Special grade	First grade	Animal feed	Edible	Animal feed	Edible	Animal feed	Cotton textiles	Animal feed	–
Moisture % (max)	13.0	14.0	13.0	14.0	13–14.0	13.0	13.0	13.0	13.0	15.0	–	–
Fibre % (max)	4.0	5.0	4.0	5.0	4–5.0	2.0	3.0	1.8	2.5	2.5	2.3	–
Ash % (max)	2.0	3.0	2.0	3.0	2–3.0	1.8	2.5	1.8	2.5	2.0	1.0	–
HCN % (max)	–	–	–	–	–	–	0.03	–	0.03	–	–	0.02
Starch % (min)	72.0	70.0	72.0	70.0	70.0	–	–	–	–	82.0	75.0	–
Crude protein % (min)	–	–	–	–	–	–	–	–	2.0	–	–	–
Fat/ether extract % (min)	–	–	–	–	–	–	0.4	–	0.4	–	–	–

*Length 2 cm.
Diameter 0.4 cm and 0.8 cm.

Table 2

Specifications for starch

	USA$^{13, 14}$			India$^{10, 11}$		UK^{16}	Sri Lanka^{15}	
	Grade A	Grade B	Grade C	Edible use	Cotton textiles	Commercial use	Paper making Grade A	Paper making Grade B
Moisture (max)	23.5	12.5	14.0	13.0	15.0	8–12.0	15.0	15.0
Ash (max)	0.15	0.25	0.50	0.4	0.4	–	4.0	4.0
Fibre (max)	–	–	–	0.2	0.6	–	–	–
Protein (max)	–	–	–	–	0.3	–	–	–
Ether extract (max)	–	–	–	–	0.2	–	–	–
Viscosity g/ml water* (max)	11/150	17/150	20/150	–	–	–	–	–
Viscosity of 2% paste in secs in Redwood	–	–	–	–	44.0	–	–	–
No. 1 Viscometer at 75°C (min) pH	4.5–6.5	4.5–6.5	4.5–6.5	4.5–7.0	4.8	–	5–8.3	5–8.5

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